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Report on the Science-  
Driven Assessment  
of **Large Research  
Infrastructure Projects  
for the National  
Prioritisation Process**

## IMPRINT

Report on the Science-driven Assessment of Large Research Infrastructure Projects  
for the National Prioritisation Process

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## CONTENTS

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<b>Preliminary remarks</b>	<b>5</b>
<b>Summary</b>	<b>7</b>
<b>A. The national prioritisation process for large research infrastructure projects</b>	<b>9</b>
<b>A.I Overview of the process</b>	<b>12</b>
<b>A.II Science-driven assessment by the German Science and Humanities Council</b>	<b>16</b>
II.1 Review by working groups	18
II.2 Assessment by the committee	19
<b>A.III Overview of the submitted draft proposals for research infrastructures and the working groups</b>	<b>19</b>
III.1 Interdisciplinary Data, Information and Computing Infrastructures	22
III.2 Medical Research, Medical Physics and Biomedicine	24
III.3 Process, Systems and Life Cycle Engineering and Information Technology	25
III.4 Quantum Technologies and Materials Science	27
III.5 Particle Physics and Nuclear Physics	28
III.6 Astrophysics and Astronomy	29
<b>B. Committee assessments and recommendations</b>	<b>32</b>
<b>B.I Assessment of the recommended projects</b>	<b>32</b>
I.1 CREATION	34
I.2 DALI	36
I.3 ET	38
I.4 HBS-I	40
I.5 IceCube-Gen2	43
I.6 LEGEND-1000	45
I.7 PETRA IV	47
I.8 RIDLOP	49
I.9 SCALA	51
I.10 SLICES-DE	53
I.11 XLZD	55
<b>B.II Assessment of the additional projects</b>	<b>57</b>
II.1 AMR	57
II.2 DZTO	59
II.3 EBRAINS-D	61
II.4 EST	62
II.5 FlexiPlant	64

II.6	Future-NMR	66
II.7	GRICE-NET	68
II.8	GUFI-14T	69
II.9	KNMR	71
II.10	LARC	72
II.11	MD-MAXI	74
II.12	$\mu$ e-Bauhaus Erlangen	75
II.13	naProKi	77
II.14	NLP	78
II.15	ORCHEStRa	80
II.16	OSIRIS	82
II.17	PrecFer4innoP	84
II.18	Q-MUC	85
II.19	SKAO	87
II.20	SuperCoHD	89
II.21	TerraNet	91
<b>C.</b>	<b>Outlook and recommendations</b>	<b>93</b>
<b>C.I</b>	<b>Individual evaluation of the projects on the shortlist</b>	<b>93</b>
<b>C.II</b>	<b>Reflection on the process and recommendations</b>	<b>94</b>
<b>Appendix</b>		<b>102</b>
	List of abbreviations	103
	List of figures	112
<b>Contributors</b>		<b>113</b>

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# Preliminary remarks

In 2024, the German Science and Humanities Council (Wissenschaftsrat – WR) was asked by the then Federal Ministry of Education and Research (BMBF), now the Federal Ministry of Research, Technology and Space (BMFTR), to carry out a science-driven assessment process for large research infrastructure projects as part of a national prioritisation process. The process was to be orientated on a pilot phase carried out from 2011 to 2013 |<sup>1</sup> and the National Roadmap Process carried out from 2015 to 2017 |<sup>2</sup> and further developed in line with current needs. The subject matter were extensive investments in research infrastructures from all scientific fields, including upgrades and German involvements in international projects. The WR has set up a mandated committee consisting of WR members and additional experts to carry out the process independently. The committee was further asked to participate in a regular continuation of the process.

This report by the committee summarises the results of the science-driven assessment and makes recommendations for the further development of the national prioritisation process. In this sense, it should also be read as documentation of a learning process. In addition to the WR and the BMFTR as the initiator, it addresses the scientific institutions that submitted draft proposals for large research infrastructures. The committee expresses its gratitude to them for participating in the prioritisation process, which required considerable effort in the conception of research infrastructures. Finally, the assessment report also addresses scientific organisations in Germany as well as further science policy stakeholders at the national, European and global levels. In addition to the science-driven assessment, the prioritisation process also included a costs and risks assessment as well as an assessment of the potential for innovation and transfer. The reports on the results of these two assessment strands will be published separately by the BMFTR.

|<sup>1</sup> German Science and Humanities Council (2013): Report on the Science-driven Evaluation of Large Research Infrastructure Projects for the National Roadmap (Pilot Phase); Cologne. URL: [https://www.wissenschaftsrat.de/download/archiv/2841-13\\_engl](https://www.wissenschaftsrat.de/download/archiv/2841-13_engl)

All web links in this publication were last accessed on 15 December 2025.

|<sup>2</sup> German Science and Humanities Council (2017): Report on the Science-driven Evaluation of Large-scale Research Infrastructure Projects for Inclusion in a National Roadmap; Cologne. URL: [https://www.wissenschaftsrat.de/download/archiv/6410-17\\_engl](https://www.wissenschaftsrat.de/download/archiv/6410-17_engl)

**6** Many experts who are not members of the committee participated in the working groups as part of the assessment process. The committee would like to thank them in particular for their differentiated reviews of the projects.

The committee adopted the assessment report (German version) on 25 September 2025 and presented it to the WR during its meetings from 29 to 31 October 2025. This document is a translation of the report. The German original text prevails.

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# Summary

In 2024, the German Science and Humanities Council (Wissenschaftsrat – WR) was asked by the then Federal Ministry of Education and Research (BMBF), now the Federal Ministry of Research, Technology and Space (BMFTR), to conduct a science-driven assessment process for large research infrastructure projects as part of a national prioritisation process and to take part in the development of the further procedure and the conception of its regular continuation. To this end, it set up a mandated committee to carry out the process independently.

The assessment of the submitted projects was carried out in two stages: a subject-specific review by working groups based on four dimensions (scientific potential, scientific utilisation, relevance for Germany as a location of science and research, and feasibility from a scientific perspective) and a subsequent interdisciplinary assessment by the committee. The aim was to recommend the most promising projects to the BMFTR for inclusion on a shortlist. Of the 32 projects to be assessed, the committee recommended eleven to the BMFTR, two of which were alternatives to one another. After combining the results of the science-driven assessment with the results of a costs and risks assessment as well as an assessment of the potential for innovation and transfer, the BMFTR included nine projects on the shortlist, which was published on 8 July 2025.

At the request of the BMFTR, the mandated committee of the WR will evaluate the projects included on the shortlist individually. This **individual evaluation** is not competitive, but rather formative in nature and aims to provide recommendations for implementation to the respective responsible institutions of the projects and the BMFTR.

For the further development and continuation of the process, the committee recommends that the BMFTR conducts the **national prioritisation process on a regular basis**. The participation in the process indicates that there is great potential in the German science system for nationally significant research infrastructures that can combine scientific performance, open use and high relevance for Germany as a location of science and research. A continuous prioritisation process should include both regular competitive selection procedures and, in the sense of a roadmap, a substantive examination of research infrastructures as an area of scientific performance in a national and international context. As Europe's largest research location, Germany needs

8 such strategic and long-term prioritisation of large research infrastructures that address scientific communities, act as (international) hubs for scientific and technological expertise, and reduce fragmentation and unnecessary redundancies. The process should be carried out at intervals that allow for timely consideration of technical and technological developments and ensure the reliability of regular calls for draft proposals.

The committee recommends maintaining the **structural and disciplinary openness of the process**. The prioritisation process should remain accessible to projects from all scientific fields and take into account different types of infrastructure and institutions. At the same time, the committee encourages exchange with academic fields that have been underrepresented to date, such as the social sciences and humanities (SSH), agricultural, food and nutritional sciences, as well as environmental and earth system sciences, in order to promote their participation in the process. In order to initiate cooperation between comparable or complementary projects at an early stage and to promote synergies, the committee also recommends promoting greater **exchange between potential projects**.

Projects should continue to be submitted in the form of **draft proposals** in order to make the process easily accessible, especially for projects in the early stages of planning. In addition, it should be possible to submit non-binding project outlines. The **threshold values** for initial installation costs of 50 million euros (and 20 million euros for projects in the SSH) are still considered reasonable and should be retained.

The committee particularly emphasises the importance of **digital and digitised research infrastructures**. These have a transformative character for scientific work and are of great importance for the competitiveness of Germany as a location of science and research and for data sovereignty.

In summary, the recommendations aim to continue the process on a permanent basis as a strategic prioritisation of research infrastructure projects that takes the diversity of the German science system into account.

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# A. The national prioritisation process for large research infrastructure projects

In 2024, the Federal Ministry of Education and Research (BMBF), now the Federal Ministry of Research, Technology and Space (BMFTR), initiated a national prioritisation process for large research infrastructures. The Ministry asked the German Science and Humanities Council (Wissenschaftsrat – WR) to carry out a science-driven assessment of the submitted projects as a central component of this prioritisation process. The WR was also asked to take part in the development of the further process and the conception of its regular continuation. To this end, the WR set up a mandated committee.

As part of the assessment, the committee examined a large number of submitted projects and gained insights into current developments in the establishment of large research infrastructures. Overall, it became clear that there is great potential in the German science system for research infrastructures that can combine scientific performance, open use and high relevance for Germany as a location of science and research.

Research infrastructures play a key role in the performance, innovative strength and international competitiveness of Germany and Europe as locations for science and business. Their importance for scientific progress in a wide range of research areas, for the development of cutting-edge technologies, for the training of skilled workers and for the development of solutions to grand societal challenges has been increasingly recognised in recent years. Higher education institutions, non-university research institutions and departmental research facilities operate infrastructures of different sizes and with different access options. |<sup>3</sup> Since 2013, the WR has designated the operation of scientific

|<sup>3</sup> The Leibniz Association currently has around 140 Research Infrastructure (RI) at its institutes: see <https://www.leibniz-gemeinschaft.de/infrastrukturen/forschungsinfrastrukturen-in-der-leibniz-gemeinschaft/uebersicht-der-forschungsinfrastrukturen> (only available in German). In 2021, the Helmholtz

infrastructures alongside research, teaching and transfer as the fourth performance area of the science system. |<sup>4</sup> The importance of research infrastructures is also recognised at European level: the European Strategy Forum for Research Infrastructures (ESFRI), founded in 2002, publishes a roadmap at multi-year intervals for European research infrastructures that are in preparation (projects) or have been implemented (landmarks). The current ESFRI roadmap covers 63 infrastructures across the entire scientific spectrum. |<sup>5</sup> Most recently, the Letta |<sup>6</sup> and Draghi |<sup>7</sup> reports have emphasised the importance of high-performance research infrastructures for the European Research and Innovation Area.

In continuation of the previous German roadmap processes, large research infrastructures are understood to be facilities, services or resources that have been set up specifically for scientific purposes and are provided on a medium-term to permanent basis. Specific scientific or interdisciplinary expertise is required for their proper installation, operation and utilisation. |<sup>8</sup> Research infrastructures can be located at a central site, distributed across several sites or set up virtually. The services provided by an infrastructure, or the research results and data it generates, are not used exclusively by individual researchers or scientific groups, but are in principle available to an international research community or disciplinary communities. Research infrastructures are therefore fundamentally designed for shared or open use and address larger scientific communities.

They can pursue scientific questions of different scope and address users in different ways. For example, some large equipment or facilities required to answer a specific research question can only be installed and operated by combining the scientific and technological expertise of several institutions and through cross-institutional and cross-border funding. The research results of such research infrastructures, which focus on specific questions, are usually first used by the scientists of the participating institutions and then made

Association had around two dozen facilities for dedicated user operation and prioritised 40 planned new facilities: see [https://www.helmholtz.de/system/user\\_upload/Forschung/FIS/21\\_Helmholtz\\_FIS\\_Roadmap\\_English.pdf](https://www.helmholtz.de/system/user_upload/Forschung/FIS/21_Helmholtz_FIS_Roadmap_English.pdf). The DFG's information portal on RIs, RIsources, lists nearly 400 RIs with external usage options: see [https://risources.dfg.de/home\\_en.html](https://risources.dfg.de/home_en.html)

|<sup>4</sup> German Science and Humanities Council (2013): *Perspektiven des deutschen Wissenschaftssystems*; Cologne / Bielefeld, p. 25 f. URL: <https://www.wissenschaftsrat.de/download/archiv/3228-13.html> (only available in German).

|<sup>5</sup> European Strategy Forum on Research Infrastructures (2021): *Roadmap 2021. Strategy Report on Research Infrastructures*. URL: <https://roadmap2021.esfri.eu/media/1295/esfri-roadmap-2021.pdf>

|<sup>6</sup> Letta, E. (2024): *Much more than a Market. Speed, Security, Solidarity. Empowering the Single Market to deliver a sustainable future and prosperity for all EU Citizens*. URL: <https://www.consilium.europa.eu/media/ny3j24sm/much-more-than-a-market-report-by-enrico-letta.pdf>

|<sup>7</sup> Draghi, M. (2025): *The future of European competitiveness*; Luxembourg. URL: [https://commission.europa.eu/topics/eu-competitiveness/draghi-report\\_en](https://commission.europa.eu/topics/eu-competitiveness/draghi-report_en)

|<sup>8</sup> German Science and Humanities Council (2017): *Report on the Science-driven Evaluation of Large-scale Research Infrastructure Projects for Inclusion in an National Roadmap*; Cologne, p. 8. URL: [https://www.wissenschaftsrat.de/download/archiv/6410-17\\_engl](https://www.wissenschaftsrat.de/download/archiv/6410-17_engl)

available to the entire scientific community after a specified embargo period. Examples of this include experimental facilities or detectors in astrophysics or particle physics.

Other research infrastructures serve to answer research questions from different disciplines by opening their facilities and large equipment to external scientists for research. Access is often controlled by a selection process, and external scientists are supported to different degrees by the institution's technical and scientific staff when using the facilities. Examples of research infrastructures that enable research in a variety of disciplines include user facilities such as particle accelerators, but also research vessels.

Another type provides interested users with digital data, services or resources that they can use for their research. Access is often intended for specific user groups, but in some cases (processed) data is available to all interested parties. Examples of digital data infrastructures include social sciences panels and medical databases. With the installation of the German National Research Data Infrastructure (NFDI) in 2020, a nationwide, multidisciplinary research infrastructure has been established that secures and makes research data available across institutions. |<sup>9</sup> In recent years, digital resources such as computing capacities have also been installed within the framework of research infrastructures, for example for research on and with artificial intelligence (AI), high-performance computing (HPC) and digital twins.

Finally, meeting and research centres such as Institutes for Advanced Studies or synthesis centres, where the exchange and discussion of scientific issues are central, can be understood as social research infrastructures.

The establishment and operation of large research infrastructures require considerable financial resources and therefore strategic decision-making processes. For this reason, the prioritisation of research infrastructures is a proven approach both for individual disciplinary communities (such as medicine |<sup>10</sup> or astrophysics |<sup>11</sup>), interdisciplinary scientific organisations (such

|<sup>9</sup> German Science and Humanities Council (2025): Strukturevaluation der Nationalen Forschungsdateninfrastruktur (NFDI); Cologne. DOI: <https://doi.org/10.57674/wcdc-6d36> (only available in German)

|<sup>10</sup> Impens, N. et al. (2023): EURAMED rocc-n-roll European Research Roadmap for Medical Applications of Ionising Radiation for Better and Individualised Healthcare to Improve Patients' Lives. URL: <https://roccnroll.euramed.eu/wp-content/uploads/2024/01/EURAMED-rocc-n-roll-Roadmap.pdf>

|<sup>11</sup> Saintonge, A. et al. (Eds.) (2023): A Strategic Plan for European Astronomy. The ASTRONET Science Vision and Infrastructure Roadmap 2022-2035. URL: [https://www.astronet-eu.org/wp-content/uploads/2023/05/Astronet\\_RoadMap2022-2035\\_Interactive.pdf](https://www.astronet-eu.org/wp-content/uploads/2023/05/Astronet_RoadMap2022-2035_Interactive.pdf)

as the Helmholtz |<sup>12</sup> or the Leibniz Association |<sup>13</sup>), a number of countries (such as France |<sup>14</sup>, the United Kingdom |<sup>15</sup> or Australia |<sup>16</sup>) and international platforms such as ESFRI. With the national prioritisation process for research infrastructures, the BMFTR is now implementing such a process for the third time.

The following section first presents the national prioritisation process for large research infrastructures (A.I) and the science-driven assessment by the WR committee (A.II). Chapter A.III provides an overview of the submitted draft proposals and introduces the working groups with their content and structural priorities. Chapter B presents the results of the assessment of the submitted draft proposals, divided into recommended and non-recommended projects. This is followed in Chapter C by an outlook, which also includes recommendations for the development of the further process and the conception of its regular continuation.

## **A.I OVERVIEW OF THE PROCESS**

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The Federal Government's investment decisions regarding new or existing research infrastructures of national and international significance entail long-term commitments that tie up large amounts of public funds. A competitive, science-driven process that is open to all disciplines and types of institutions therefore not only guarantees the selection of the most promising projects, but also legitimises the correspondingly high level of funding in the science system, and towards Parliament and the public. In 2024, the then BMBF initiated the further developed process for prioritising nationally significant research infrastructures, in the course of which draft proposals for possible large research infrastructures were assessed. The assessment was carried out in three parallel strands in the form of a central science-driven assessment, an assessment of costs and risks, and a complementary assessment of the potential for innovation and transfer (Figure 1). As in the 2015 – 2017 National Roadmap Process, this

| <sup>12</sup> Hermann von Helmholtz Association of German Research Centres (2021): Helmholtz Roadmap Research Infrastructures 2021; Frankfurt am Main. URL: [https://www.helmholtz.de/system/user\\_upload/Forschung/FIS/21\\_Helmholtz\\_FIS\\_Roadmap\\_English.pdf](https://www.helmholtz.de/system/user_upload/Forschung/FIS/21_Helmholtz_FIS_Roadmap_English.pdf)

| <sup>13</sup> Gottfried Wilhelm Leibniz Science Association (2022): Leibniz Roadmap for Research Infrastructures; Berlin. URL: [https://www.leibniz-gemeinschaft.de/fileadmin/user\\_upload/Bilder\\_und\\_Downloads/Forschungsinfrastrukturen/Leibniz-Roadmap/Broschuere\\_Leibniz\\_Roadmap\\_Forschungsinfrastrukturen.pdf](https://www.leibniz-gemeinschaft.de/fileadmin/user_upload/Bilder_und_Downloads/Forschungsinfrastrukturen/Leibniz-Roadmap/Broschuere_Leibniz_Roadmap_Forschungsinfrastrukturen.pdf)

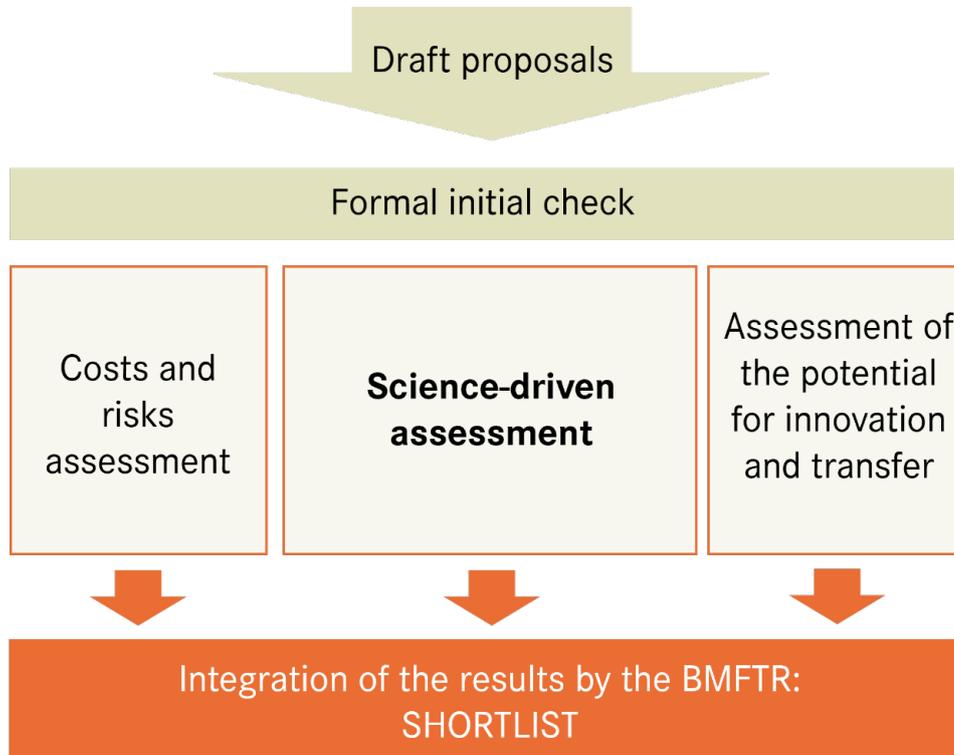
| <sup>14</sup> Ministère de l'enseignement supérieur et de la recherche et de l'innovation (2022): French national strategy on research infrastructures; Paris. URL: <https://www.enseignementsup-recherche.gouv.fr/sites/default/files/2023-02/french-national-strategy-on-research-infrastructure—2021-26489.pdf>

| <sup>15</sup> UK Research and Innovation (2019): The UK's research and innovation infrastructure: opportunities to grow our capability; London. URL: <https://www.ukri.org/wp-content/uploads/2020/10/UKRI-201020-UKInfrastructure-opportunities-to-grow-our-capacity-FINAL.pdf>

| <sup>16</sup> Department of Education, Skills and Employment (2022): 2021 National Research Infrastructure Roadmap; Canberra. URL: <https://www.education.gov.au/download/13735/2021-national-research-infrastructure-roadmap/26919/2021-national-research-infrastructure-roadmap/pdf>

process was open to all interested state and state-accredited higher education institutions as well as legally independent, non-university research institutions in Germany.

**Figure 1: Overview of the process with the three assessment strands**



Source: Own illustration.

The aim of the process in the draft proposal phase was to

- \_ select the research infrastructures that are a priority for expanding and maintaining Germany's leading position in research and innovation in international competition and the performance of the German science system as part of the European Research Area;
- \_ assess the resilience of the plans submitted and the expected funding requirements in order to reduce risks during implementation; and
- \_ to highlight the potential contributions of the planned research infrastructures to innovation and transfer beyond scientific knowledge gain, thus enabling these to be included in the further decision-making process.

The requirements for submitting draft proposals for planned research infrastructures were:

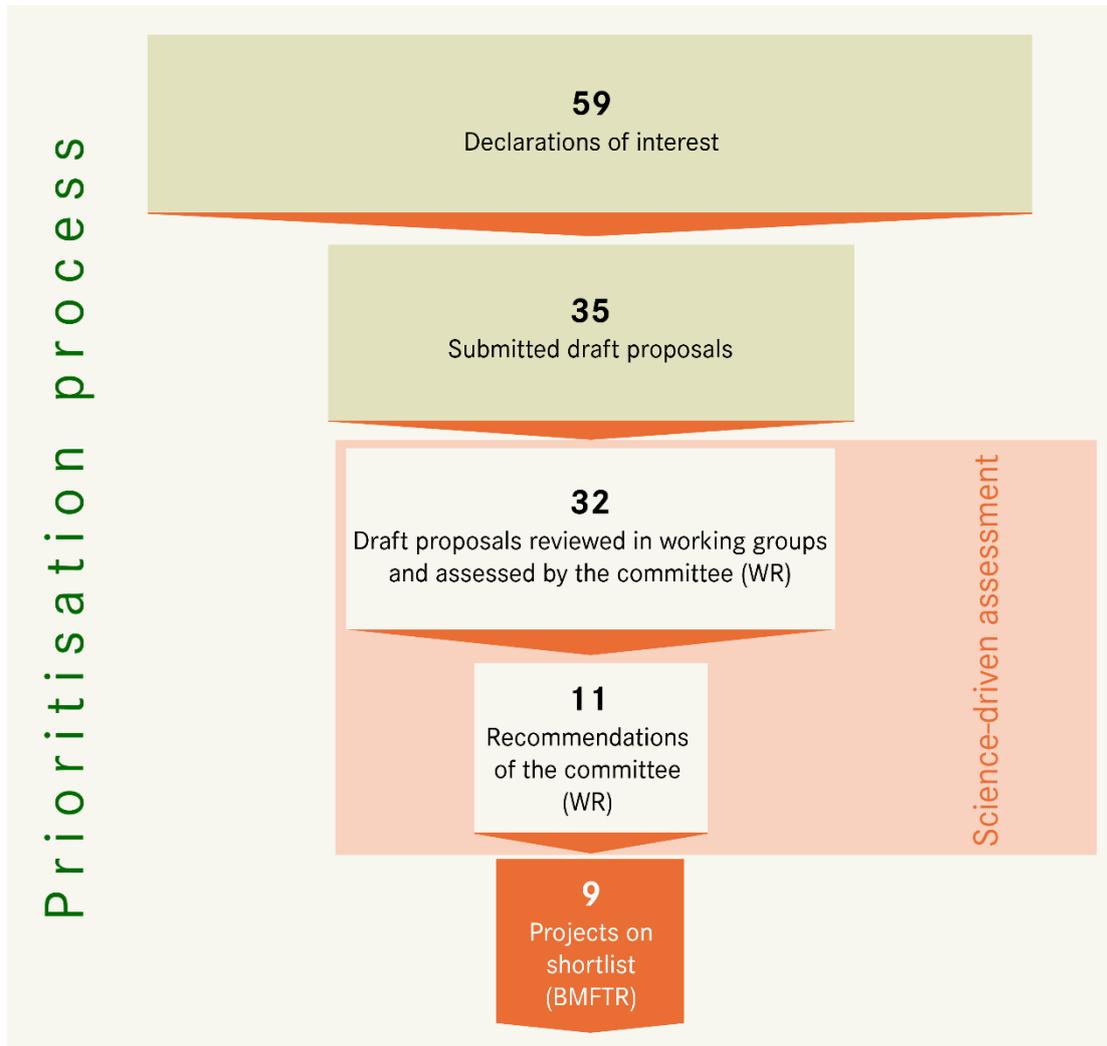
- \_ The planning of a new, large research infrastructure or a substantial upgrade of existing research infrastructures that enable new scientific insights. It was also possible to submit a proposal for a new involvement in an international

- research infrastructure. The decisive factors here were the scientific added value of the project beyond existing structures;
- \_ the national significance in terms of research policy;
  - \_ a long operating life of at least ten years;
  - \_ open, science-driven access (in the sense of open science), mainly serving research purposes;
  - \_ exceeding the threshold for initial installation costs of 50 million euros or 20 million euros for research infrastructures in the social sciences and humanities (SSH); and
  - \_ research and development (R&D) and organisational considerations at an appropriate stage of planning so that implementation can be achieved within four years.

The call for draft proposals for the national prioritisation process was announced by the then BMBF in July 2024. A declaration of interest for a planned research infrastructure had to be submitted by the end of August 2024, which was a prerequisite for the subsequent submission of a draft proposal. A total of 59 declarations of interest were submitted (Figure 2). The complete draft proposals, including appendices, had to be received by the end of October 2024. The draft proposals were to be prepared on the basis of guidelines published at the same time as the announcement of the prioritisation process. |<sup>17</sup> In addition to the 30-page draft proposal, the documents to be submitted consisted of eleven appendices, which included a financing concept and a risk analysis. A total of 35 draft proposals were submitted. After a review of the formal criteria, 32 projects were approved for the process and submitted for assessment.

|<sup>17</sup> For the announcement of the prioritisation process (only available in German), see [https://www.bmftr.bund.de/DE/Forschung/Wissenschaftssystem/Forschungsinfrastrukturen/InternationaleEinrichtungen/\\_documents/240617\\_priorisierungsverfahren\\_fis.html](https://www.bmftr.bund.de/DE/Forschung/Wissenschaftssystem/Forschungsinfrastrukturen/InternationaleEinrichtungen/_documents/240617_priorisierungsverfahren_fis.html); and to download the guidelines <https://www.bmftr.bund.de/SharedDocs/Downloads/DE/2024/Guidelines-and-addenda.zip>

**Figure 2: Quantitative overview of the science-driven assessment process within the prioritisation process**



Source: Own illustration.

After a formal initial review, the submitted research infrastructure projects underwent a process consisting of three parallel assessment strands, with the science-driven assessment forming the central strand (Figure 1). In addition, the following two were organised by the BMFTR:

- \_ An assessment of costs and risks by a panel of experts who assessed the resilience of the submitted funding plans and financing concepts over the entire life cycle (construction, operation and, if applicable, dismantling) and analysed the technical, organisational and financial risks as well as risk management. Sustainability aspects relating to the construction, operation and, if applicable, dismantling of the research infrastructures were also taken into account.

\_ A complementary assessment of the potential for innovation and transfer by a panel of international experts. A comprehensive understanding of transfer served as basis for assessing the potential impact of the research infrastructures beyond their scientific potential for Germany as part of the European Community. In addition to the social impacts, this understanding of transfer also included expected contributions to future provision and transformation, as well as to technological sovereignty in Germany and Europe. The potential for innovation and transfer was assessed for selected projects that had been considered in more detail in the course of the science-driven assessment for possible recommendation for the shortlist.

The science-driven assessment was carried out by a mandated committee of the WR on the basis of a review by external experts (see A.II). As a result, the committee recommended eleven projects to the BMFTR for inclusion on the shortlist, two of which were alternatives to each other. After combining the results with those of the other two assessment strands, the BMFTR included nine projects on the shortlist (Figure 2). Inclusion on the shortlist means that the selected research infrastructures are highly suited to contributing to Germany's future viability and are therefore among the projects to be implemented as a priority from a research policy perspective.

The publication of the shortlist compiled on the basis of all three assessment strands in July 2025 marked the conclusion of the draft proposal phase of the prioritisation process and the beginning of individual evaluations of the successful projects by the WR committee. In this second phase, the projects on the shortlist are evaluated individually. The aim is to make recommendations for further implementation and for the funding of the projects.

#### **A.II SCIENCE-DRIVEN ASSESSMENT BY THE GERMAN SCIENCE AND HUMANITIES COUNCIL**

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The aim of the science-driven assessment of the draft proposals by the WR committee mandated for this purpose was to identify the projects that are a priority for the performance of the German science system and the expansion and maintenance of its leading international position. To this end, a differentiated, science-driven assessment of the projects was carried out on the basis of uniform criteria. This was done in two stages: review and assessment. First, the 32 draft proposals were clustered into six working groups based on their thematic or structural similarities (see A.III) and reviewed individually (Figure 3). On this basis, the committee assessed all projects and made recommendations to the BMFTR for inclusion on the shortlist.

The review and assessment were based on four dimensions:

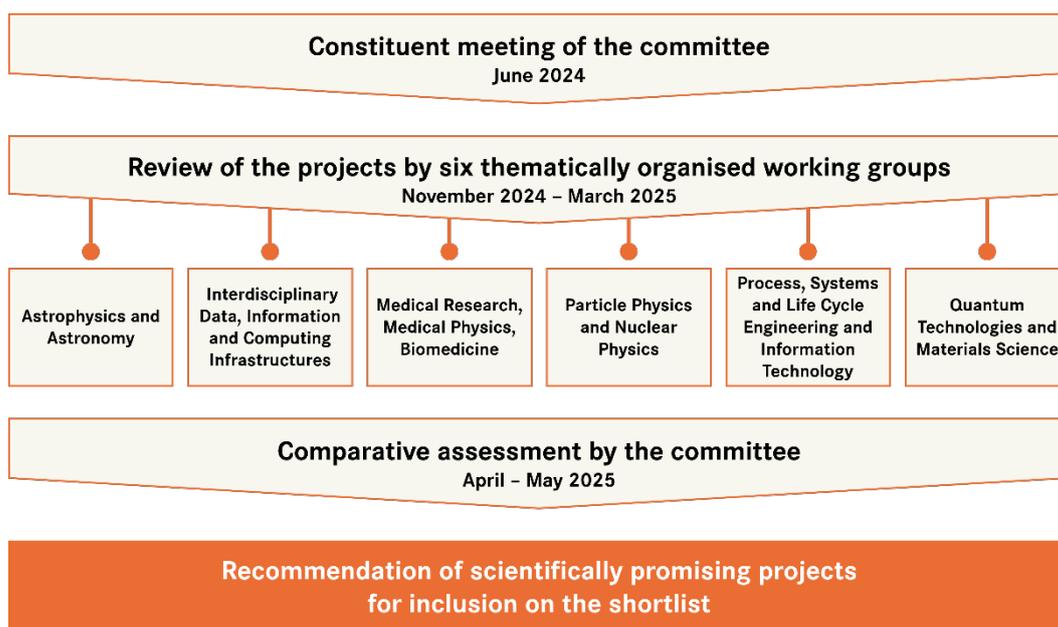
1 – The dimension of **scientific potential** covered the significance of the research questions to be addressed, the added value offered by the research infrastructures in answering them, the diversity and range of the research areas addressed, the potential for interdisciplinary and transdisciplinary cooperation, and the adaptability to newly emerging questions.

2 – In the dimension of **scientific utilisation**, the anticipated demand from user groups and the design of access to the planned research infrastructure were assessed. The institutional and disciplinary diversity and internationality of the users were also taken into account. In addition, research data management (RDM) and measures for quality assurance of use, as well as standards of good scientific practice in handling research data, such as reuse and secondary use of data, were examined.

3 – In the dimension of **relevance for Germany as a location of science and research**, the relevance of the project for research in Germany, Europe and throughout the world was considered. The decisive factor was the extent to which the research infrastructure can contribute to Germany's attractiveness, visibility and competitiveness in science and research. This includes Germany as a location of scientific excellence and as a cooperation partner.

4 – The dimension of **feasibility from a scientific perspective** took into account the technical, personnel and institutional requirements of the project (including the organisational structure and governance) as well as the consequences of associated risks. The assessment focused on the extent to which the research infrastructure can guarantee the feasibility of the scientific and technical solutions and the scientific milestones. The status of planning and implementation also played a role in this.

**Figure 3: Process of the science-driven assessment by the committee of the German Science and Humanities Council**



Source: Own illustration.

## II.1 Review by working groups

The working groups formed were composed of a working group chair, specialist and non-specialist rapporteurs, and several experts. The working group chair was assigned to a committee member who also took on the subject-related reporting in the committee or was supported in this by a second member. Another member of the committee who had no close professional ties to the working group's field of science took on the role of non-specialist rapporteur. Two proven experts – mostly from abroad – were recruited for each draft proposal. The working groups' reviews were carried out during two-day meetings held in person on the basis of written initial appraisals by these experts. After a joint, detailed discussion of each project, all experts gave a rating according to the four dimensions mentioned above, first individually and then as a joint review on a scale from “not sufficient” to “excellent”:

- \_ “Excellent” meant that the project significantly exceeded expectations and standards in the respective dimension, was presented in an outstandingly clear and convincing manner, and was expected to have a unique impact.
- \_ “Very good” meant that the project met the expectations and standards with high satisfaction, was presented in a well-structured and comprehensible way, and was expected to have a very positive impact.
- \_ “Good” meant that the project met most of the expectations and standards, was presented in a comprehensible manner, but could be more convincing – including in its presentation – and would have a positive but limited impact.

– “Not sufficient” meant that the project did not meet basic expectations and standards, was presented in an unclear, unstructured or incomprehensible manner, and was expected to have little or no positive impact.

This form of grading served the internal communication process and was an important starting point for comparative discussion. The result of this first stage of the science-driven assessment was thus joint reviews by the working group, in which each project received a rating for each assessment dimension. |<sup>18</sup>

## II.2 Assessment by the committee

The aim of the second stage was for the committee to assess all projects across the working groups and recommend the most promising projects for inclusion on the shortlist. The specialist and non-specialist rapporteurs informed the committee about the projects, the discussion process and the joint reviews of the respective working groups. Recommendations for the further development of the projects, points of criticism and questions from the working groups about the draft proposals were also included here. The committee discussed and assessed the projects across all scientific fields, calibrating the review results from the various disciplines as necessary and taking into account the strengths and weaknesses of the individual proposals, also against the background of their respective fields of expertise. The committee thus arrived at an assessment of each project as “recommended” or “not recommended” for inclusion on the shortlist. The resulting list of recommendations formed the final outcome of the science-driven assessment process in the draft proposal phase and was submitted to the BMFTR in June 2025.

### **A.III OVERVIEW OF THE SUBMITTED DRAFT PROPOSALS FOR RESEARCH INFRASTRUCTURES AND THE WORKING GROUPS**

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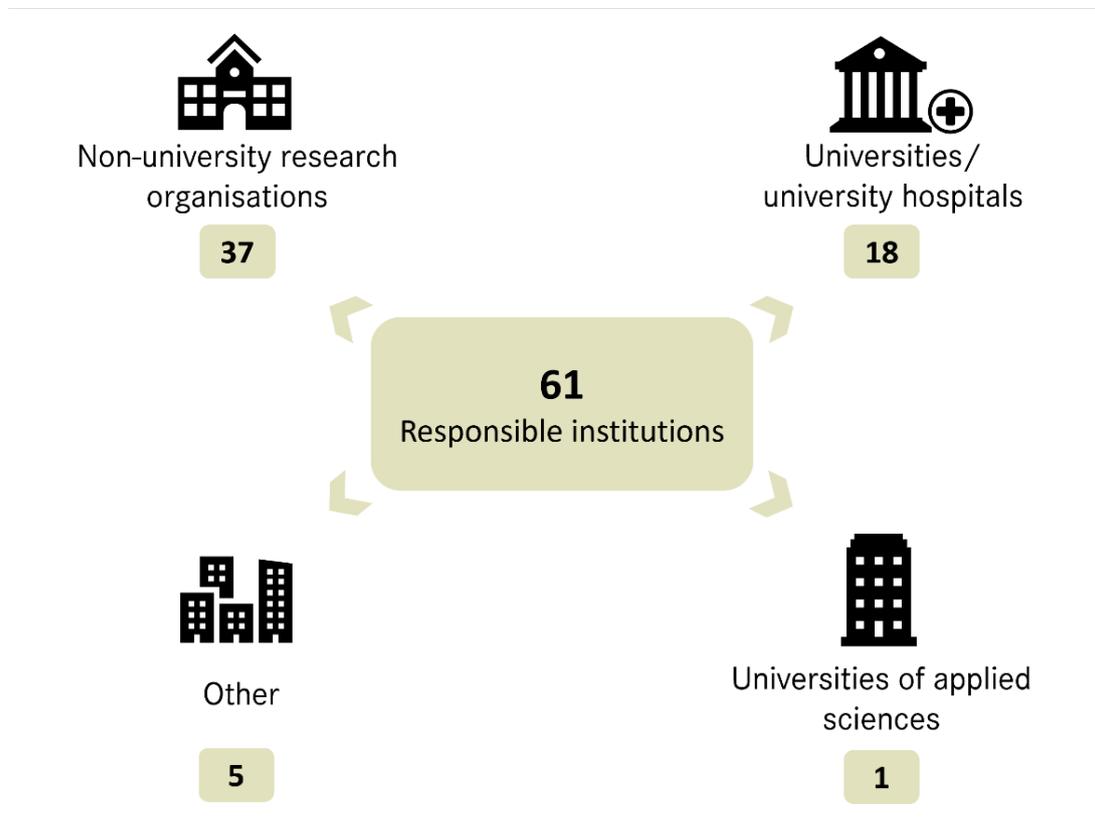
A total of 61 different responsible institutions were involved in the 32 draft proposals for research infrastructure projects that were reviewed and assessed as part of the process (Figure 4). Approximately half of the projects were submitted by a single responsible institution, while the other half were supported by consortia or collaborations between several institutions. Half of the projects submitted cooperatively are planned to be jointly managed by non-university research institutions |<sup>19</sup> and universities/university hospitals.

|<sup>18</sup> The results of this assessment were communicated individually to the responsible institutions after completion of the draft proposal phase, but are not part of this assessment report.

|<sup>19</sup> Max Planck Institutes and Fraunhofer institutes are categorised as responsible institutions in the following, although they are not legally independent and although the Max Planck Society and Fraunhofer Society were considered the organisations eligible to submit applications.

Some large institutions participated in several projects with different institutes or departments.

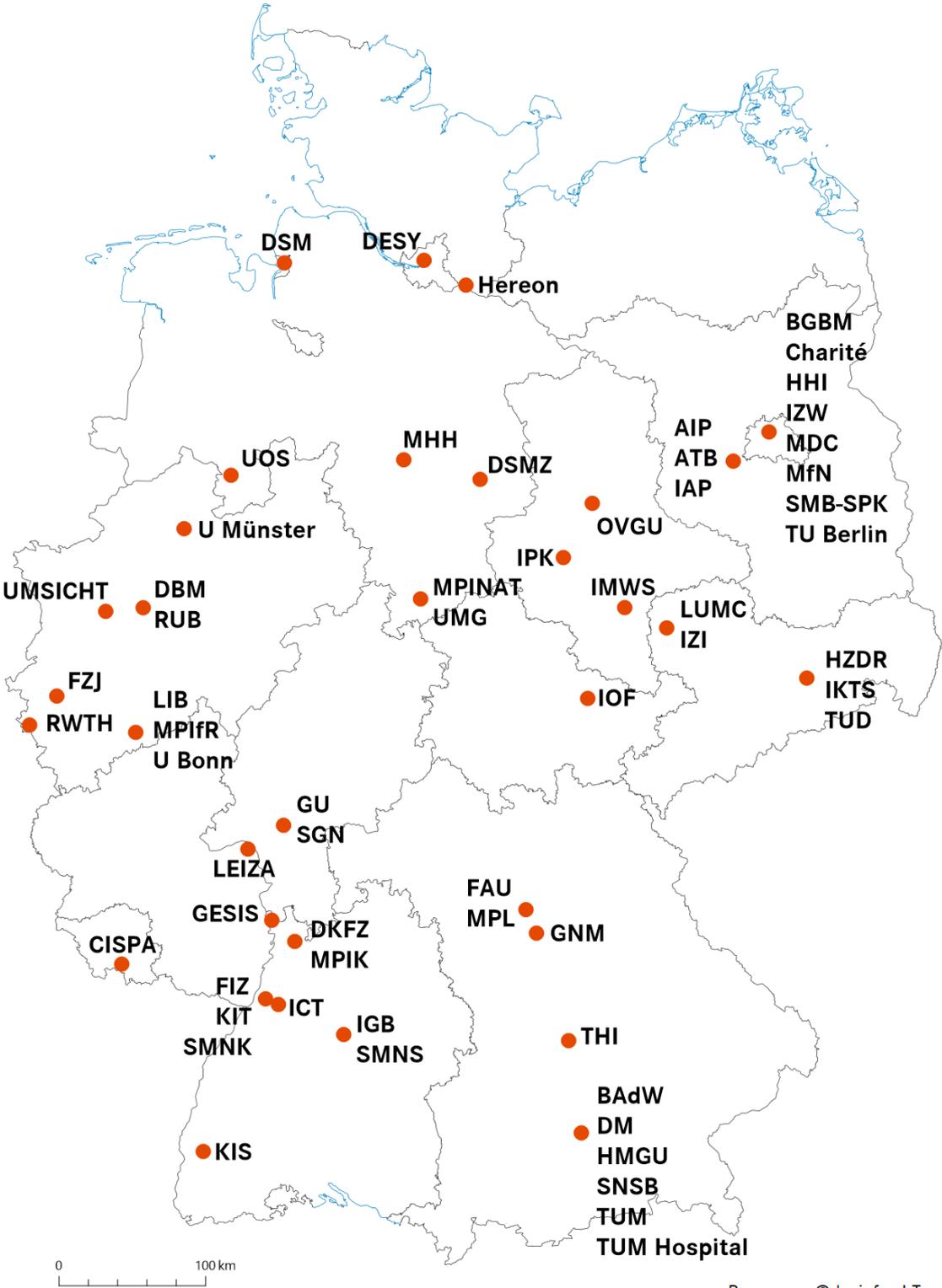
**Figure 4: Distribution of responsible institutions by type**



Source: Own illustration.

With 37 non-university research institutions, this type of institution accounts for the largest share of responsible institutions. Universities and university hospitals are represented 18 times. In addition, five academies or other institutions and one university of applied science acted as responsible institutions. Draft proposals were submitted from almost all federal states, with most of the responsible institutions coming from Bavaria, North Rhine-Westphalia and Baden-Württemberg (Figure 5). The installation costs for the projects ranged from 50 million euros to 1.8 billion euros. With 21 projects, the majority calculated installation costs of between 51 million euros and 200 million euros. The total installation costs for all 32 projects amounted to approximately 8.5 billion euros.

Figure 5: Geographical distribution of the responsible institutions



Source: Own illustration (see list of abbreviations for the names of the institutions).

The committee assigned the 32 draft proposals to the following six working groups:

- 1 – Interdisciplinary Data, Information and Computing Infrastructures
- 2 – Medical Research, Medical Physics and Biomedicine
- 3 – Process, Systems and Life Cycle Engineering and Information Technology
- 4 – Quantum Technologies and Materials Science
- 5 – Particle Physics and Nuclear Physics
- 6 – Astrophysics and Astronomy

Various aspects were taken into account when assigning the draft proposals to the working groups, such as the thematic and methodological similarities between the projects and similarities in terms of the issues addressed, the areas of application or the planned structures. Due to the high number of projects, some scientific fields were differentiated further than others. In the field of natural sciences and engineering, for example, where 21 projects were located, the physics projects alone were assigned to two different working groups focusing on astrophysics and astronomy as well as particle physics.

Experts were recruited to review the draft proposals in accordance with established standards for scientific evaluation procedures. This ensured, on the one hand, that the necessary expertise was available in the areas and disciplines relevant to the respective working group and, on the other hand, that each working group could be staffed with experts who are familiar with the structures of the German science system. They were also familiar with the current subject- and institution-related dynamics in Germany, especially with regard to the format of the research infrastructure, and with the international scientific landscape. Each working group was composed of six to ten scientists, most of whom were international, from various disciplines.

The following subchapters (A.III.1 – A.III.6) describe the composition of the working groups and the projects included in them.

### III.1 Interdisciplinary Data, Information and Computing Infrastructures

The working group *Interdisciplinary Data, Information and Computing Infrastructures* dealt with six proposals for digital research infrastructures from the fields of life sciences, natural sciences, engineering, humanities and social sciences. They are planned as infrastructures that combine information and/or communication technologies in the form of software and hardware and aim to make them usable for specific research areas. Mostly designed as decentralised or virtual research infrastructures, they are intended to establish comprehensive data, information

or computing infrastructures and contribute to the digital collection, processing, provision and/or use of a wide variety of research data. The projects intend to provide open access to diverse and extensive data sets or to implement and reproduce digital research experiments. Thus, they aim to contribute to the digitisation in science and the improvement of RDM.

What the projects have in common is the combination of different scientific fields and their interdisciplinary orientation. It is planned to connect specific research fields with sub-areas of computer science such as machine learning (ML), data management or image and language processing as well as the integration of disciplines such as computational linguistics or neuromorphic computing. The majority of the projects focus on the application of AI, while some of them also aim to contribute to its further development. Some projects are also characterised by a transdisciplinary component with which they aim to have an impact on politics and society, such as climate policy or the health sector. By utilising research data, social, digital and health challenges are to be addressed or human-environment interactions investigated.

The goal is to strengthen Germany as a location of science and research with regard to computational social sciences, network technology, neuroscience and climate research, among others. The proposed research infrastructures present strong national, but also international (especially European) networking, which is reflected in the large number of partner and in some cases also responsible institutions as well as the connection of two projects to ESFRI research infrastructures.

The following projects were reviewed by the working group:

- \_ EBRAINS-D: *EBRAINS Germany* is a planned digital research infrastructure with a focus on the exploration of the structure and functioning of the human brain through the application of AI models and other computational resources.
- \_ OSIRIS: The *Open Science Information and Research Infrastructure* is supposed to be developed as a digital knowledge infrastructure that integrates German natural, technical and cultural collections.
- \_ RIDLOP: The *Research Infrastructure for Data from Large Online Platforms* is planned as a digital research infrastructure that provides access to data from large online platforms and enables it to be analysed.
- \_ SLICES-DE: The *Scientific Large Scale Infrastructure for Computing/Communication Experimental Studies* intends the German participation in a digital European research infrastructure for experimental research in the field of data processing and communication.
- \_ SuperCoHD: The project is planned as a *High-Performance Computing Infrastructure for Health Data* with a focus on health research in an integrated data space.

\_ TerraNet: *Toward a terrestrial digital twin of Germany for sustainable use and management of the land surface* is a project to establish a terrestrial digital twin of Germany consisting of environmental observation data.

### III.2 Medical Research, Medical Physics and Biomedicine

Cell and gene therapy, organoid research, imaging techniques and interdisciplinary large animal research constitute the focal points of the six projects in the working group *Medical Research, Medical Physics and Biomedicine*. They aim at the development, translation and clinical application of new treatment and diagnostic methods aiming to achieve progress in medical research, personalised treatment and care. The majority of the projects are interdisciplinary in nature, with methodological and content-related interfaces between biomedical research questions, physical-technical methods and, to some extent, agricultural and veterinary sciences. As a result, most of the projects involve collaboration between researchers from fields such as medicine, biology, physics, computer science, veterinary science and engineering. One focus, particularly within organoid, gene and cell therapy projects, is the (clinical) use of AI. This will include the use of AI for automated production and development of therapies, for data processing and analysis, and for diagnostic procedures.

With regard to the context of the working group, the committee noted that Germany already holds an international leadership position in some of the scientific areas mentioned and that scientific institutions are performing excellently. This applies, for example, to high-field imaging technology or cell and gene therapies. There is a need for action in other areas: For example, in biomedicine and translational research, transdisciplinary centralised research infrastructures for large animal studies are needed at international level and specifically in Germany to advance the production and medical application of cell and gene therapies. In medical research, the operation of research infrastructures is considered to be a comparatively well-established dimension of scientific performance, which is reflected on the European level, for example, in the ESFRI Roadmap, in which research infrastructures in the field of health and food form a separate domain.<sup>|20</sup> However, life science research infrastructures in Germany and Europe face particular regulatory, safety-related and societal challenges due to the research involving living organisms. Within this working group, this is particularly evident in the internationally highly competitive organoid, cell and gene therapy research – examples include the challenges involved in standardising advanced therapy medicinal products (ATMPs) – as well as in large animal translational research, which also requires particular ethical sensitivity.

<sup>|20</sup> European Strategy Forum on Research Infrastructures (2024): ESFRI Landscape Analysis 2024; p. 61–75. URL: [https://landscape2024.esfri.eu/media/coqdoq0q/20240604\\_la2024.pdf](https://landscape2024.esfri.eu/media/coqdoq0q/20240604_la2024.pdf)

The following projects were reviewed by the working group:

- \_ CREATION: The planned *Centre for Gene and Cell Therapy in Regeneration and Transplantation* aims to improve gene and genetically modified cell therapies (cell and gene therapies, CGTs) and accelerate their production processes.
- \_ DZTO: *The German Center for Translational Organoid Research* is a planned virtual service hub that aims to transfer organoid technology into clinical application.
- \_ GRICE-NET: *The German Research Infrastructure Network for Cell-based Medicine* is to be established as a national research network for the rapid development of cell-based therapies, and in particular of ATMPs.
- \_ GUF1-14T: *The German Ultra-High-Field Imaging Center 14 Tesla MRI* is intended to enable whole-body magnetic resonance imaging (MRI) in humans at a magnetic field strength of 14 Tesla.
- \_ LARC: *The Large Animal Research and Care Center* is a planned research hub for large animal studies at the intersection of agricultural sciences, veterinary sciences and translational medicine.
- \_ MD-MAXI: *The Magdeburg Center for (Bio-)Medical Advanced X-Ray Imaging* plans to use novel brilliant X-rays for biomedical imaging techniques.

### III.3 Process, Systems and Life Cycle Engineering and Information Technology

The six projects of the working group *Process, Systems and Life Cycle Engineering and Information Technology* are characterised by their engineering focus – from process engineering and electrical engineering to traffic engineering and technical chemistry. One mission-orientated focus, which is also reflected as an overarching, socially relevant goal, is resource efficiency and conservation. Some of the projects aim to offer appropriate technological and process-orientated solutions to this. These include optimised and sustainable production processes for chemicals and other materials as well as the utilisation of biomass. On the other hand, recycling and reprocessing processes – for example in electronics or automotive production – are intended to contribute to a sustainable circular economy in which resources are utilised efficiently and not merely consumed. One of the key objectives in the development of devices, processes and components within the research infrastructures is to improve energy efficiency. In addition to the optimisation of production and process standards, in the topic of mobility traffic environments are also to be made more efficient and safer with the help of sensors and other technologies. In terms of methodology, the projects in this working group have in common the planned extensive use of AI, in particular ML, digital twins and other Industry 4.0 instruments. These digital tools are intended to support the further development and optimisation of processes and procedures through extensive analyses and simulations. The use of a digital twin in particular should also provide external users with low-threshold, open access to the research infrastructure.

To realise their objectives, the proposed research infrastructures usually plan infrastructures in the form of pilot and demonstration facilities as well as laboratories that are aimed at specific technology readiness levels (TRL) and are intended to offer users from research and industry scaling options for their technologies and processes. Accordingly, the focus is often on (industrial) R&D.

In the context of this working group, the committee noted that Germany already has a strong international position in some of the disciplines represented – for example in the recycling industry, chemical process engineering or in the field of intelligent transportation systems. In others, there is an urgent need for action in order not to fall behind, such as in semiconductor research. However, compared to other scientific fields, the operation of research infrastructures as a scientific performance area is not common practice in some of the engineering disciplines represented here. It is noticeable that the research infrastructures of this working group are submitted by a maximum of two responsible institutions and are often not integrated into larger national or international research networks or refer to plans for such collaborations.

The following projects were reviewed by the working group:

- \_ FlexiPlant: The *Research Infrastructure for the Adaptive Processing of Complex Raw Materials* is planning the prototype of a fully automated pilot plant for raw material processing with the aim of a digitalised and agile recycling industry.
- \_  $\mu$ e-Bauhaus Erlangen: The *Mikroelektronik-Bauhaus Erlangen* envisages a research and innovation infrastructure focussing on power semiconductors with (ultra)wide bandgap and the interconnection of research, education and industry.
- \_ naProKi: The *Research Center for Sustainable Production and Circular Economy* aims to reduce energy and material consumption by developing resource-efficient production processes and recycling strategies.
- \_ ORCHEStRa: The *Open Research Center for the Holistic Exploration of Safety and Efficiency in Real Traffic* is dedicated to the high-resolution recording and processing of real-time traffic data in the form of a modular hardware and software architecture.
- \_ PrecFer4innoP: The project *Precision Fermentation for innovative Products* aims to drive innovation in the sustainable bioeconomy through precision fermentation and intelligent biorefinery systems.
- \_ SCALA: *Scale-up Green Chemistry* is designed as a research platform with a long-term testing and validation infrastructure for the scaling and transfer of sustainable processes in chemistry.

The four projects of the working group *Quantum Technologies and Materials Science* bring together scientific and technological focuses from biology, chemistry, physics, materials science, materials engineering, as well as quantum and information technologies. The planned interdisciplinary research infrastructures focus on the characterisation and development of novel quantum components, the analysis of quantum physical and material-related properties, and the development of multifunctional materials with precisely controllable properties. One aim is to make a substantial contribution to solving societally relevant challenges in areas such as quantum computing, energy and medical technology, drug development, health, energy and climate research through the use of quantum technological methods and material analysis technologies such as nuclear magnetic resonance spectroscopy (NMR) and high-field radiation sources. In NMR research, two of the projects address subject-specific challenges by seeking to overcome the traditional boundaries between the biological and materials science, as well as between solid-state and liquid-state NMR. In addition, both projects use almost identical NMR technology with comparable magnetic field strengths and frequencies. The analysis of dynamic processes and atomic structures in a wide range of materials, as well as the investigation of quantum phenomena, are further core topics of the projects, which largely see themselves as a bridge between fundamental research and industrial application.

Methodologically, the projects are characterised by a strong integration of digital tools. The use and development of AI-supported approaches for data analysis and management, as well as for the intelligent control of experimental processes, is planned to be embedded in the implementation of the projects.

The committee noted that Germany already holds an internationally recognised and, in some areas, leading position in the field of NMR and high-field research, particularly regarding applications in the life sciences. In the field of quantum technologies, on the other hand, there is still a considerable need to address existing research gaps and to systematically unlock the available scientific potential.

The following projects were reviewed by the working group:

- \_ Future-NMR: The *NMR high-field spectrometer for bio- and material sciences* will comprise three ultra-high-field nuclear magnetic resonance spectrometers for performing atomic structure analyses in the bio-, health and material sciences.
- \_ KNMR: The *Karlsruhe Nuclear Magnetic Resonance Facility* is a planned digital, analytical materials science facility for characterising materials and analysing quantum mechanical structures.

- \_ Q-MUC: *Quantum Munich Labs* is designed as a national deep tech innovation centre for novel solid-state-based quantum components and hardware-specific software for the production and characterisation of quantum sensors and processors.
- \_ DALI: The *Dresden Advanced Light Infrastructure* comprises a series of planned accelerator-based THz light sources for analysing matter under the influence of high-intensity electromagnetic THz fields, with the aim of gaining a physical, chemical and biological understanding of novel, short-lived states of matter on ultrafast time scales.

### III.5 Particle Physics and Nuclear Physics

The working group *Particle Physics and Nuclear Physics* dealt with four research infrastructure projects addressing key areas of modern physics. The focus is on X-ray and neutron technologies for atomic analysis and materials research, photonic technologies and energy solutions. This working group is also characterised by the interdisciplinary nature of its projects, which aim to bridge the gap between fundamental physics research and applied research questions.

There is a particular overlap in terms of content in the further development and utilisation of large-scale research facilities for characterising matter at the atomic and molecular level. The aim is to use innovative radiation sources and suitable methods to gain deeper insights into the structure and dynamics of various materials as well as biological and technical systems. The projects reflect a wide range of technological approaches that address different scientific objectives and fields of application. They range from high-resolution, time-resolved imaging for the analysis of dynamic processes to the development of novel sources for materials and life science applications to technologies for optical information processing, quantum communication and sensor technology. Methodological innovations are intended to be made usable for key technological areas such as energy, communication, computer technology and medical technology.

A key element of the projects is their strong data-driven focus. All of the projects' technological facilities and large-scale equipment promise to generate exceptionally high volumes of data, some of which will be analysed using AI-supported methods and complex data management systems, requiring specific measures for exploitation, use and provision. Accordingly, there are clear parallels between the projects in the development and application of new methods for analysing and processing, that are relevant to the materials and life sciences as well as to industrial innovations. In addition, there are high requirements in terms of safety, regulation and social acceptance, especially for nuclear facilities. The projects face challenges regarding complex approval and licensing procedures as well as strict regulations on the one hand, and international competitiveness on the other.

Large research infrastructures are an established format in nuclear and particle physics and follow in the tradition of the science-oriented concept of large-scale equipment. In addition, this working group is pursuing concepts that have not yet been realised in Germany or Europe, which poses particular challenges in terms of planning, risk management and governance. The projects are predominantly designed as national research infrastructures. While some projects are supported by large, established institutions, others rely on cooperation between several institutes or universities.

The following projects were reviewed by the working group:

- \_ AMR: The *Advanced Modular Reactor* is designed as a generation IV research reactor that intends to combine low-emission energy supply, medical isotope production and research in fusion technology, neutron imaging and materials science.
- \_ HBS-I: The *High Brilliance Neutron Source – Phase I* is a neutron source with pulsed high-current proton beams with the aim of securing access to neutron experiments for science and industry and providing medical radioisotopes.
- \_ NLP: The *National Laboratory for Photonic Science and Technology* aims to create a platform for innovation in communication, quantum computing, sensor technology and medical technology by developing key photonic technologies.
- \_ PETRA IV: The *ultimate 4D X-ray Microscope* is a planned upgrade of the PETRA III facility at DESY and, as a 4D X-ray microscope, is supposed to enable material analysis, real-time visualisation and data-driven material design.

### III.6 Astrophysics and Astronomy

The six projects of the working group *Astrophysics and Astronomy* address key questions in astrophysics, astronomy, (astro)particle physics and cosmology. The focus is on the discovery and exploration of astronomical objects and astrophysical, cosmic and solar phenomena, which in some cases go beyond the Standard Model of physics. The spectrum of the research projects brought together in this working group ranges from the search for dark matter and the neutrinoless double beta decay to the investigation of black holes, neutron stars and matter under extreme conditions, as well as the dynamics of the solar magnetic field. Moreover, a variety of methods and technologies for the detection of neutrinos, radio and gravitational waves, and light are involved. To this end, the projects provide for the installation and expansion of observatories, telescopes and experiments that can be considered complementary with regard to specific questions in the context of multi-messenger astrophysics/astronomy. The overarching goal is to fundamentally deepen our understanding of the universe in terms of its origins, structures and interactions.

Compared to existing research infrastructures in the field, the research programmes of these projects generally require a significant increase in the

performance and sensitivity of the systems, which is to be achieved through the development and implementation of innovative technologies. The development of powerful methods for improving detection systems and suppressing background signals involves areas such as semiconductor technology, microelectronics, cryogenics, quantum optics and materials science, resulting in many interdisciplinary connections. Due to the extensive data sets generated in the process of detection activities, the use of AI and the development of algorithms for data reduction and further processing also play a central role.

The projects of the working group represent German contributions to large international research infrastructures. Such collaborations are well established in astrophysics and astronomy, not least because the observatories, telescopes and experiments that are central to these fields can often only be realised through cooperation between various international players due to their technical complexity, financial dimensions and the need for special sites (e.g. due to ideal conditions for certain observations). Since the beginning of Donald Trump's second presidency, numerous US participations in international research projects have been called into question due to budget cuts and the withdrawal from international cooperation. This puts some of the projects in this working group at risk of not being implemented, as they are counting on significant financial support from the US or are relying on cooperation with US scientific and government agencies. Since the draft proposals were submitted and reviewed before the current US administration took office, this risk was not taken into account by the responsible institutions or experts. The assessment of these projects was therefore carried out regardless of the possible withdrawal of US cooperation. However, in future investment decisions, it will be important to consider risks arising from scientific dependencies carefully. |<sup>21</sup>

In the areas covered by the working group's projects, German scientists already hold a leading international position in the committee's view. This applies to astronomy – especially radio and gravitational wave astronomy – as well as to neutrino research and solar physics. The members of the involved responsible and partner institutions have an expertise that is crucial to the success of the respective projects. This results not least from previous or existing contributions to research infrastructures on which the submitted projects are based.

The following projects were reviewed by the working group:

\_ EST: The *European Solar Telescope* is a planned solar observatory on La Palma (Spain) with a 4.2-meter-aperture main telescope.

|<sup>21</sup> German Science and Humanities Council | Wissenschaftsrat (2025): Science and security in times of global political upheaval | Position paper; Cologne. <https://doi.org/10.57674/v8dp-8269>

- \_ ET: The *Einstein Telescope* is a planned gravitational wave observatory designed to observe compact object merger signals from black holes and neutron stars across cosmic times.
- \_ IceCube-Gen2: The project plans to upgrade an existing neutrino observatory at the South Pole to improve detection capabilities.
- \_ LEGEND-1000: The *Large Enriched Germanium Experiment for Neutrinoless Double Beta Decay* aims to investigate fundamental properties of neutrinos and address key questions in particle physics and cosmology.
- \_ SKAO: The *Square Kilometre Array Observatory* aims to extend the development of a network of radio astronomical and computing facilities in Africa, Australia and Europe.
- \_ XLZD: A *xenon-based low-background observatory for astroparticle physics* is designed to search for dark matter and neutrinoless double beta decay, as well as to address key questions in particle physics and cosmology.

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# B. Committee assessments and recommendations

At the beginning of this chapter, the proposals for research infrastructures (RIs) recommended by the committee for inclusion on the shortlist are stated and the shortlist drawn up by the Federal Ministry of Research, Technology and Space (BMFTR) is presented. This is followed by the assessment results of the recommended (B.I.1–B.I.11) and non-recommended proposals (B.II.1–B.II.21).

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## B.I ASSESSMENT OF THE RECOMMENDED PROJECTS

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The committee recommended the following eleven projects to the BMFTR for inclusion on the shortlist:

- \_ *Center for Gene- and Cell-Therapy in Regeneration and Transplantation* – CREATION, as a research centre for gene and cell therapy in the field of medical research.
- \_ *Dresden Advanced Light Infrastructure* – DALI, as a light source in the THz frequency range in the form of a user facility in the field of experimental physics.
- \_ *Einstein Telescope* – ET, as an observatory for gravitational waves for research in the field of astrophysics.
- \_ *High Brilliance Neutron Source – Phase I* – HBS-I, as a high-current accelerator-based neutron source in the form of a user facility in the field of experimental physics.
- \_ *IceCube-Gen2*, as a neutrino observatory for research in the field of astrophysics.
- \_ *The ultimate 4D X-ray Microscope* – PETRA IV, as an X-ray light source in the form of a user facility in the field of experimental physics.
- \_ *Research Infrastructure for Data from Large Online Platforms* – RIDLOP, as a digital platform for analysing data from large online platforms in the field of social sciences.
- \_ *Scale-Up Green Chemistry* – SCALA, as a long-term testing and validation infrastructure in the field of applied green chemistry.

- \_ *Scientific Large Scale Infrastructure for Computing/Communication Experimental Studies* – SLICES-DE, as a digital experimental platform in the field of information and communications technology.
- \_ *Large Enriched Germanium Experiment for Neutrinoless Double Beta Decay* – LEGEND-1000, as an experiment for the search for neutrinoless double beta decay in the field of astroparticle physics.
- \_ *A xenon-based low-background observatory for astroparticle physics* – XLZD, as a xenon observatory for the search for neutrinoless double beta decay in the field of astroparticle physics.

LEGEND-1000 and XLZD share the same thematic focus, namely research into neutrinos. The committee therefore recommended to the BMFTR that only one of these projects be included on the shortlist, taking into account the costs and risks assessment as well as the innovation and transfer potential.

The list of recommended projects does not represent a ranking, but is to be understood as an equal recommendation. It shows that projects from all six working groups were able to convince the committee and that the recommendation to the BMFTR covers a broad spectrum of disciplines and a heterogeneous selection of infrastructures. Although the overarching group of physics, whose research is largely based on working with large equipment and extensive facilities, is strongly represented, the social sciences, medicine, materials science and computer science are also included.

The result of the science-driven assessment in the form of the eleven recommendations by the WR committee was combined by the BMFTR with the two strands for assessing costs and risks as well as innovation and transfer potential. |<sup>22</sup> The shortlist compiled on this basis was presented publicly by the BMFTR together with the WR on 8 July 2025. |<sup>23</sup> The shortlist represents the most promising RIs with the potential to make a major contribution to the performance of the German science and research system. Nine projects with an investment volume of over 2.5 billion euros have been selected for prioritised further development. The shortlist includes:

- \_ CREATION
- \_ DALI
- \_ Pre-phase for the ET
- \_ HBS-I
- \_ IceCube-Gen2

|<sup>22</sup> The results of these two assessment strands are published by the BMFTR in separate reports.

|<sup>23</sup> [https://www.bmftr.bund.de/DE/Forschung/Wissenschaftssystem/Forschungsinfrastrukturen/Priorisierungsverfahren/priorisierungsverfahren\\_node.html](https://www.bmftr.bund.de/DE/Forschung/Wissenschaftssystem/Forschungsinfrastrukturen/Priorisierungsverfahren/priorisierungsverfahren_node.html) (only available in German).

\_ LEGEND-1000  
 \_ PETRA IV  
 \_ RIDLOP  
 \_ SLICES-DE

In the following, the assessment reports of the eleven projects recommended by the committee are presented. After a brief description of each project, the results are presented along the four dimensions of **scientific potential**, **scientific utilisation**, **relevance for Germany as a location of science and research** as well as **feasibility from a scientific perspective**.

### I.1 CREATION

Center for Gene- and Cell-Therapy in Regeneration and Transplantation (CREATION)

Responsible institutions: Hanover Medical School (MHH) | University Medical Center Göttingen (UMG) | Leipzig University Medical Center (LUMC) | Fraunhofer Institute for Cell Therapy and Immunology (IZI)

Installation costs: approx. 85 million euros

CREATION is a collaborative initiative uniting expertise across the fields of immunology, regenerative medicine, molecular biology, and clinical translation, aiming to advance cell and gene therapies (CGTs) through both ex vivo and in vivo approaches. CREATION's objective is to offer broadly accessible "off-the-shelf" therapies and to enhance manufacturing processes through AI-driven automation. This approach addresses critical health challenges such as cancer, genetic disorders and organ failure. To overcome the current fragmentation in CGT development, CREATION plans to establish an infrastructure that integrates research, production, and clinical applications, and is strategically distributed across Hanover, Göttingen and Leipzig, including enhancements to existing Good Manufacturing Practice (GMP) facilities in Hanover and Leipzig.

#### *Assessment*

With regard to its **scientific potential**, CREATION is a most promising RI of outstanding significance for Germany as a location of science and research. The promised acceleration in the large-scale production of gene therapy medicinal products as well as future applications of developed vectors and technologies in the fields of cancer, autoimmune diseases, organ failure and tissue regeneration are strong and compelling features of the project. The project therefore has the potential to improve ex vivo and in vivo therapies in Germany and to facilitate a shift from ex vivo to in vivo therapies. The focus on monogenic diseases is a distinguishing feature of CREATION; the approaches are particularly promising for applications such as deafness and transplantation. The project addresses

several fields of action from the National Strategy for Gene and Cell-Based Therapies, such as technology transfer, improvement of quality and capacity for GMP production, and R&D. |<sup>24</sup> As an improving infrastructure for research and translation in CGTs is essential, CREATION makes a significant contribution to this goal as an RI. The second research strand, which relates to the development of new therapies, the novelty of CREATION's anticipated scientific achievements in relation to other research institutions, as well as the selection process for cooperation partners and their composition, should be further elaborated.

CREATION's **scientific utilisation** concept convincingly describes potential user groups and the usability of services at various locations. Given the high demand for RIs regarding CGTs, access to CREATION is very attractive to a broad and diverse research community from the fields of molecular biology, immunology, oncology and regenerative medicine. The focus on providing services for both internal and external users, the capacities and the compact structure of the RI have a high utilisation value. The planned close cooperation between the responsible institutions promises to contribute to reducing the fragmentation of current CGT development. Regarding the planned 200 to 300 external users per year, it would be desirable to further specify the quantification of these user numbers, the access processes and the adequate coverage of user demand. More detailed explanations about the monitoring of the executive committee, the number of facilities to be built and the specific number of Gene Therapy Medicinal Products (GTMPs) to be produced per year are also needed.

The project is **relevant for Germany as a location of science and research**: Due to international competition and the importance of CGTs, there is an urgent need for Germany to take further steps in gene and cell therapy research. While the USA, China, the UK and some EU countries have already created effective ecosystems for the development of gene- and cell-based therapies, Germany still faces specific challenges in coordinating the relevant stakeholders and transferring these therapies into medical care. CREATION has the potential to give Germany a head start in international research through improved production and medical application of CGTs, thereby significantly strengthening its position in this field. The project counteracts the lack of specialised and well-connected large RIs in Europe. CREATION also addresses current issues and objectives that are highly relevant at European level, such as the development of tools, technologies and digital health solutions for personalised medicine. |<sup>25</sup> CREATION is also in a position to provide patients worldwide with more affordable access to the resulting innovative treatments. Greater integration of

|<sup>24</sup> Berlin Institute of Health at Charité (BIH), Translational research unit at Charité - Universitätsmedizin Berlin (2024): National Strategy for Gene and Cell-Based Therapies; Berlin. URL: [https://www.bihealth.org/fileadmin/GZT/National\\_Strategy\\_for\\_GCT\\_EN.pdf](https://www.bihealth.org/fileadmin/GZT/National_Strategy_for_GCT_EN.pdf)

|<sup>25</sup> For the most pressing issues in medicine from the EU's perspective, see European Commission (2025): Horizon Europe Work Programme 2025. 4. Health; Brussels. URL: [https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/wp-call/2025/wp-4-health\\_horizon-2025\\_en.pdf](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/wp-call/2025/wp-4-health_horizon-2025_en.pdf)

the project into the national and international research landscape with links to other RI and research institutions in the field would further benefit CREATION.

The extensive expertise and well-founded cooperation between the four responsible institutions as well as the network of institutional partners gives reason to expect high **feasibility from a scientific perspective**. The project does not rely on a single technology, which further increases its adaptability to changing or newly emerging questions. Although the development of new therapies comes with considerable financial, regulatory and ethical risks, the responsible institutions address these risks very convincingly from a scientific perspective. The plan to increase investments in production facilities to achieve more economical production of therapies is plausible. Details on the planned use of AI for GTMP production (bearing in mind that this affects human health and safety aspects) can further sharpen the proposal.

Overall, considering the international competition and the need for progress in the production and medical application of gene and cell therapies in Germany, the committee recommended CREATION as an ambitious and promising project of outstanding importance for Germany as a location of science and research. By including it on the shortlist, the BMFTR has followed this recommendation.

## 1.2 DALI

Dresden Advanced Light Infrastructure (DALI)

Responsible institution: Helmholtz-Zentrum Dresden-Rossendorf (HZDR)

Installation costs: approx. 292 million euros

DALI is an accelerator-based facility designed to provide terahertz (THz) light sources for investigating the states and functions of matter under high-intensity electromagnetic THz fields and on ultra-short time scales. By combining high field strengths, repetition rates and continuous tunability in conjunction with ultrashort electron and positron pulses, DALI is expected to open new research opportunities in materials science and semiconductor research, thereby advancing understanding in numerous physical, chemical and biological fields. The results are anticipated to make an important contribution to medical applications, AI and secure quantum communication. Research focuses include the investigation and development of materials and components under the influence of THz fields. DALI comprises two superconducting electron accelerators that are coupled to generate coherent, high-intensity THz radiation. The facility is designed as an international research institution for researchers in the fields of materials science, solid-state physics, chemistry and electronics. Based on the experimental concepts of the already established THz source TELBE, DALI will in future succeed the existing ELBE facility at the HZDR.

DALI represents a promising RI with outstanding **scientific potential** for breakthroughs in biology, chemistry, physics, medicine, materials science and semiconductor research. The project is of high scientific relevance and has the potential to address a wide range of issues in an interdisciplinary manner. It offers a convincing range of services in the fields of photoemission spectroscopy, ultrafast electron diffraction and positron beams for defect kinematics, which are expected to lead to groundbreaking experiments for the analysis of quantum materials, biomolecular processes and chemical reactions. DALI offers the prospect of substantial advances in the understanding of complex dynamic processes – for example, in the field of energy dissipation or the dynamics of topological materials. DALI is well positioned to establish new research approaches and make a long-term contribution to scientific excellence. As the successor to the existing ELBE facility and with its technologically ambitious concept, DALI is expected to establish itself as a central institution in THz research. With a clear focus on both theoretical and application-oriented issues, DALI is predestined to promote innovative approaches and provide new impetus for THz research.

The **scientific utilisation** concept takes into account the highest standards in terms of functionality, user-friendliness and accessibility. DALI aims to analyse dynamic processes in a wide variety of materials, opening up prospects for attracting new user groups, especially from disciplines that have been underrepresented in THz research to date. Although the majority of users is expected to come from Europe, the planned access modalities open up opportunities for intensive international cooperation and could help DALI establish itself as a central institution for global THz research. The estimated 8,000 hours of use per year suggest that the RI's interdisciplinary focus on materials science, life sciences and electrical engineering will not only advance translational research in the life sciences, but also enable industrial applications. The German scientific community is expected to account for around 50 % of usage, with user groups from Europe and other countries significantly expanding the scope of applications. Located at the HZDR, DALI is also well positioned to strengthen close ties with academic institutions worldwide and to establish itself as a leading institution in global THz research. An efficient RDM and effective communication contribute to this, supported by the long-standing operational experience of the ELBE facility. Although it clearly focuses on fundamental research, DALI is predestined to give new impetus to the photoemission spectroscopy and electron diffraction communities. The RI is anticipated to be a powerful platform for international cooperation and provide lasting stimulation for research in numerous disciplines.

DALI has the potential to sustainably increase the attractiveness of **Germany as a location of science and research** in international comparison and to ideally

complement existing photon research initiatives at national and European level. Despite existing international infrastructures such as FELIX (Netherlands) and CLIO (France), DALI has the potential to achieve outstanding international visibility due to its unique characteristics, high field strength and thematic breadth. DALI promises to establish itself as the preferred facility for the growing global THz community. In addition, the project has the potential to specifically promote innovation in various disciplines from materials science and life sciences. The scientific expertise underlying the project and a tight European network provide good conditions for ensuring a viable concept and successful start of operation. In the long term, DALI offers the prospect of economic commercialisation and the opportunity to address complex engineering challenges – aspects that can contribute to consolidating Germany’s position in the global research environment of THz science.

The positive assessment of **feasibility from a scientific perspective** is underpinned by the proven expertise and track record of the responsible institution. The design is based on proven concepts from the predecessor facility ELBE and is supported by a stringent and exemplary risk management strategy. The close connection between facility know-how and scientific excellence suggests that the project will substantially enrich THz research. The project is technically sound, excellently planned and has a robust and realistically implementable overall concept with clear timelines. This gives rise to high expectations for a successful implementation and promises further strengthening of the HZDR as a scientific institution.

Based on this assessment, the committee recommended DALI as a highly promising, interdisciplinary RI of outstanding relevance for THz research in Germany. By including it on the shortlist, the BMFTR has followed this recommendation.

### 1.3 ET

#### Einstein-Telescope (ET)

Responsible institutions: RWTH Aachen University | University of Münster | Ruhr University Bochum (RUB) | Dresden University of Technology (TUD) (representing the German Center for Astrophysics [DZA])

Installation costs: approx. 635 million euros (German contribution)

The ET aims to extend existing astronomical observation capabilities by complementing electromagnetic astronomy with gravitational wave detection. The ET will observe compact object merger signals from black holes and neutron stars across cosmic times and investigate other cosmological signatures, thereby advancing fundamental physics. These observations are expected to provide deeper insights into black holes, matter under extreme conditions, and cosmological phenomena. To achieve this, the ET and its industrial partners will

leverage technological advances in precision interferometry and quantum technologies for a facility to be built deep underground to minimise disturbances. As a large-scale international project, the ET brings together an interdisciplinary European team spanning the fields of physics, geology, engineering, as well as materials and environmental sciences. Through its contributions to multi-messenger astrophysics/astronomy, ET aims to play a pivotal role in astronomy, astrophysics, astroparticle physics, and cosmology.

#### *Assessment*

The ET has exceptional **scientific potential** and marks a significant advancement in gravitational wave astronomy. As one of only two planned next-generation observatories – besides the U.S. Cosmic Explorer – the ET is expected to provide a three orders of magnitude improvement over the performance of current-generation gravitational wave observatories in key parameters. It is expected that the innovative technology used will enable detailed investigations of the history of the universe, matter under extreme conditions and dark energy. Unlike current observatories, the ET will be able to detect stellar-mass black hole mergers and almost all neutron star mergers across the nearby universe. The potential of the project can be described as transformative – with impacts across astrophysics, quantum sciences, laser physics, ML and AI – and promises revolutionary contributions to our understanding of the cosmos.

The project promises exceptional potential for **scientific utilisation** and has the capacity to generate extensive, high-quality data. Although the operational team is supposed to be small, it is anticipated that large research groups will utilise the data, thereby forming a global group of several thousand users. The data management strategy is convincing and ensures effective handling, which is a decisive factor for the success of the RI. It is expected that the ET will strengthen global gravitational wave research and also promote international collaboration in the observation of the full electromagnetic spectrum.

The participation in the ET offers **Germany** a unique opportunity to ensure its scientific and technical leadership in gravitational wave astronomy and to further strengthen its position as a **location of science and research**. As a major European RI, the realisation of the ET requires strong multinational cooperation. With a planned contribution of approximately 25 % of the total project costs, Germany will play a key role in the planning, installation and operational phases. It is expected that German expertise in engineering, computing and other research fields central to the project will drive the technological progress of the ET and consolidate Germany's international position in gravitational wave research. The unique capabilities of the ET are expected to further increase Germany's global visibility. A location within the Euregio Meuse-Rhine region or the Lusatia region in Saxony would ensure optimal integration and feedback to the German community, but even the more distant location in Sardinia would strengthen Germany's leading role in scientific innovation and gravitational

wave research. Regardless of the still open question of location, the project will further boost international cooperation and solidify Germany's leading position in gravitational wave research for the long term.

In terms of **feasibility from a scientific perspective**, the project can be described as extremely ambitious. Despite the early stage of development, a careful assessment of scientific and technical feasibility has already been carried out, with key parameters such as laser power being analysed in detail. The ongoing site selection process is being supported by detailed geological investigations. However, geotechnical risks associated with the construction of tunnels and caverns remain challenging to assess. However, geotechnical risks associated with the construction of tunnels and caverns remain challenging to assess. Alternative configurations, such as two separate L-shaped interferometers 1,000 km apart, could mitigate these technological risks, though at the expense of reduced low-frequency sensitivity. There are still some technical challenges to be overcome, which are already being worked on – for example, in the areas of mirror cooling, the development of special fibre optic technologies and noise reduction. Finally, there are some shortcomings in the risk strategy that need to be addressed, such as unclear milestone planning and a lack of detailed cost estimates.

It is expected that the ET will advance not only gravitational wave astronomy but also fundamental physics through new observations. The complex design of the RI promotes significant technical and scientific innovations. Against this background, the committee has recommended the project.

After bringing together the results of the three assessment strands, the BMFTR has included a pre-phase for the ET on the shortlist, during which, among other things, the location and configuration are to be clarified. The committee supports this and recommends an evaluation of the ET at the end of the pre-phase in order to make recommendations on Germany's further participation in the project. With regard to the location issue, the committee points out that this should be decided based on scientific criteria.

#### 1.4 HBS-I

##### High Brilliance Neutron Source – Phase I (HBS-I)

Responsible institutions: Forschungszentrum Jülich (FZJ) | Helmholtz-Zentrum Hereon

Installation costs: approx. 118 million euros

HBS-I aims at developing an innovative compact accelerator-driven neutron source. The project utilises pulsed high-current proton beams to produce neutrons through a low-energy nuclear reaction in a target material, requiring less radiation shielding and moderator cooling compared to traditional neutron

sources. The facility is designed to produce small diameter neutron beams, allowing experiments with smaller sample volumes. This is intended to support research in the materials and life sciences, including materials for energy conversion and storage, nanomaterials, quantum materials, protein structures and biomaterials. Additionally, HBS-I aims to secure the supply of essential medical radioisotopes. HBS-I's flexible, on-demand access to experiments is expected to accelerate innovation in chemical, automotive, and pharmaceutical industries. It is designed as a user facility, open to a multidisciplinary community from universities, research institutes and industry.

#### *Assessment*

HBS-I has excellent **scientific potential** and addresses a critical need for neutron sources in Germany and Europe. In view of the forthcoming shutdown of existing large-scale facilities, it will fill a significant gap in the European research landscape. The provision of high-intensity neutron beams will enable considerable progress in numerous scientific disciplines. HBS-I utilises the properties of neutrons to investigate magnetism, quantum materials, biomaterials and energy storage, placing it on a scientific par with existing neutron sources. Its technical parameters – in particular its time structure, beam size and accessibility – make HBS-I a complementary addition to large facilities such as ILL, FRM II, ESS, PSI and ISIS. Particularly noteworthy is the innovation potential in the area of target, moderator and neutron instrument concepts, which could enable the development of new neutron techniques and applications. However, it should be noted that the production of radioisotopes at HBS-I could be potentially limited due to the comparatively lower neutron flux.

With regard to the **scientific utilisation**, HBS-I plays a central role at the interface between research and industry. Its design is intended to enable various neutron scattering experiments and techniques, facilitating cutting-edge research in the materials and life sciences. Its user-friendly design and strong industrial application potential are particularly noteworthy. HBS-I is an important building block for promoting neutron research in a wide range of scientific disciplines and thus can make a significant contribution to overcoming the current shortage of accessible neutron sources. There is great interest in HBS-I within the international scientific community, provided that sufficient resources are made available for instrumentation and operation. The interdisciplinary orientation of HBS-I also offers the potential to attract new user groups for neutron characterisation, particularly with regard to the development of innovative materials and pharmaceutical products.

HBS-I is of central **relevance for Germany as a location of science and research** in light of maintaining a leading position in neutron research and materials science. Particularly in the context of any maintenance periods, as is currently the case at the FRM II, the project is indispensable for preserving Germany's

international competitiveness in this field of research. HBS-I is expected to make an important contribution to the training of young scientists and to secure Germany's long-term expertise in the field of neutron research. HBS-I can be described as crucial for Germany's technological sovereignty, with the potential to become the most powerful non-fission-based, non-spallation-based neutron source. HBS-I should not be seen exclusively as an alternative to existing neutron sources, but rather as a targeted expansion of the availability of neutrons for research and thus as an enrichment of the European research landscape. HBS-I complements the only remaining German neutron source, FRM II in Garching, which is repeatedly restricted in its operation due to technical and regulatory challenges. Unlike reactor-based sources, HBS-I offers novel experimental possibilities and simplified, lower-risk access for science and industry due to its flexible pulse structure, high brilliance and small beam cross-sections. HBS-I is thus intended to close a key gap in the German and European research landscape and strengthen the sustainable supply of neutrons. In the European context, HBS-I expands the network of large-scale facilities – alongside ILL, SINQ, ISIS and, in future, ESS – with a powerful, nationally available high-current accelerator neutron source (HiCANS). Close integration with complementary facilities such as synchrotron radiation sources (PETRA III/IV, BESSY-II/III, ESRF) and electron microscopy (ER-C) makes HBS-I a central component of the national and European research strategy, with the ability to ensure Germany's visibility and competitiveness in neutron research.

The **feasibility of HBS-I from a scientific perspective** is very high. The ambitious schedule is considered realistic as it builds on the existing infrastructure and comprehensive expertise of the FZJ. The latter is internationally recognised as a pioneer in the development of HiCANS. The cost efficiency of HBS-I represents a particular advantage over larger neutron sources. Critical technological challenges have already been solved, so there is no doubt about the technical feasibility. Staffing levels may be too low, so the planning should be revised accordingly. In addition, a more comprehensive risk analysis is necessary, particularly with regard to financial uncertainties such as fluctuating raw material and electricity prices, which could affect the number of operating days. Furthermore, the project can be further improved by continuously adjusting the planning, specifying the research objectives and optimising the documentation.

The committee recommended HBS-I as a cost-effective, future-proof solution to the acute shortage of neutrons. Its compact design and focus on practical applications make it an indispensable component of the European research ecosystem. The committee expects that Germany will be able to further expand its leading role in neutron research with the implementation of HBS-I and enable innovations in the field of materials and life sciences. By including it on the shortlist, the BMFTR has followed this recommendation.

Responsible institutions: Deutsches Elektronen-Synchrotron (DESY) | Karlsruhe Institute of Technology (KIT)

Installation costs: approx. 71 million euros (German contribution)

IceCube-Gen2 is an expansion of IceCube, the current neutrino observatory at the South Pole, planned by an international consortium. It aims to significantly enhance the detection capabilities of neutrinos across a broader energy range. IceCube-Gen2 will combine optical and radio detection with a surface detector for cosmic air showers. Through optimised technology, it is intended to increase the detection volume and sensitivity so that the annual detection rate of cosmic neutrinos is increased tenfold and sources that are five times fainter can be identified. The radio array is expected to increase the sensitivity for the highest-energy neutrinos by two orders of magnitude. Information on certain neutrino events will be available to the public in real time, and complete data sets will be made public regularly. IceCube-Gen2 is designed to take neutrino research from the discovery phase to the precision measurement phase, while also contributing to the geoscience.

#### *Assessment*

IceCube-Gen2 offers exceptional **scientific potential** as a transformative upgrade to the existing neutrino observatory at the South Pole. With its increased sensitivity, it should be possible to explore previously undetected sources of high-energy cosmic rays, such as active galactic nuclei. This increase in performance would represent a significant advancement in neutrino detection. Currently, several neutrino observatories are under construction around the world, some of which are already collecting data – in Europe (e.g. KM3NeT), North America (e.g. P-One) and Asia (e.g. Baikal-GVD). Due to their location in the northern hemisphere, they are considered complementary to IceCube-Gen2, as they cover different areas of the sky. Most of these observatories use water as a detection medium and, according to current plans, will achieve the detection volume of IceCube, but not that of IceCube-Gen2. The upgrade, once completed, would be considered the world's largest neutrino observatory. It can be assumed that the design of IceCube-Gen2 – not least because of its location at the South Pole – will enable synergies with other scientific fields beyond astrophysics, such as geophysics, glaciology and climate research. Due to its unique energy coverage and improved sky accessibility, important contributions to neutrino astronomy, multi-messenger astrophysics/astronomy and research in dark matter and new physics are to be expected. This multidisciplinary approach promises new insights and discoveries. Overall, IceCube-Gen2 represents a great opportunity for groundbreaking research in the field of high-energy astrophysics – with the

potential to fundamentally expand knowledge of cosmic phenomena and promote international cooperation within the scientific community.

The potential for **scientific utilisation** of IceCube-Gen2 is characterised by high usability standards and a well-defined and effective access strategy. The data obtained can benefit a broad and interdisciplinary scientific community, particularly scientists working in (astro)particle physics, astronomy and glaciology. The data utilisation model is efficient, flexible and well thought out: the continuously collected data will be transmitted directly to facilities in the USA and Germany, giving members of the collaboration priority access; comprehensive data sets and analysis tools will also be made available on a regular basis. In addition, it is intended to provide multi-messenger alerts for major neutrino events to enable immediate follow-up observations by astronomical observatories worldwide. The outreach concepts are exemplary; it is expected that the planned efforts in this regard will help to foster public understanding of research and boost interest in relevant research questions and discoveries.

Given the substantial German contribution through DESY and KIT, as well as the high international visibility of the project, its **relevance for Germany as a location of science and research** is considered to be exceptional. As the second largest contributor to the project after the USA, Germany is in a position to further strengthen its international standing in the scientific community of neutrino research. Considering the improved detection capabilities of IceCube-Gen2, the participation of leading German institutions in the project will increase the visibility of the German research landscape and is likely to further consolidate its outstanding role in this field. Overall, it is expected that contributing to IceCube-Gen2 will significantly increase Germany's attractiveness as a location of science and research.

From a scientific perspective, the project's **feasibility** is given, as the necessary technical requirements are generally accessible. However, there are a number of challenges that need to be addressed, particularly with regard to the power supply, the necessary refurbishment of the South Pole station and the tight construction timeline. Based on experience with IceCube, the project timeline can be considered feasible in principle, but power consumption, especially for drilling and installation, presents a major difficulty. The limited time window for construction activities due to the extreme weather conditions at the South Pole is another critical factor that could lead to delays in production or funding, thereby posing a risk to the overall installation schedule. Against this background, effective strategies are necessary to increase work shifts and resolve funding uncertainties. It also seems important to simulate the conditions at the South Pole in order to test the devices and their reliability. Furthermore, the South Pole station needs to be refurbished, as the current infrastructure is not sufficient to adequately support IceCube-Gen2.

IceCube-Gen2 represents a significant advancement in neutrino detection and, through its installation and operation under the extreme conditions at the South Pole, has the potential to drive technical and scientific innovation. Against this background, the committee recommended IceCube-Gen2. By including it on the shortlist, the BMFTR has followed this recommendation.

## 1.6 LEGEND-1000

Large Enriched Germanium Experiment for Neutrinoless Double Beta Decay (LEGEND-1000)

Responsible institutions: Max Planck Institute for Nuclear Physics (MPIK) | Technical University of Munich (TUM)

Installation costs: approx. 67 million euros (German contribution)

LEGEND-1000 is an international research project that aims to explore the fundamental properties of neutrinos and answer key questions in particle physics and cosmology. Its main goal is the detection of neutrinoless double beta decay – a process that would show that neutrinos are their own antiparticles and also provide information about neutrino mass and insights into the matter-antimatter asymmetry of the universe. The use of innovative technologies will also enable the search for dark matter and research into physics beyond the Standard Model. To this end, large, ultra-sensitive germanium semiconductor detectors, advanced microelectronics and powerful background suppression methods, including AI, will be used, which will also benefit applications in other scientific fields such as medicine and industry.

### *Assessment*

With its attempt to detect neutrinoless double beta decay, the project has extraordinary **scientific potential**. Such a discovery would be groundbreaking for astroparticle physics and could provide answers to key questions about the properties of neutrinos, their effective mass and the origins of the matter-antimatter asymmetry of the universe. The implications of this discovery would extend far beyond particle physics to astrophysics and cosmology. Due to this significance, several large experiments to detect neutrinoless double beta decay are currently in operation or planned – in Europe, North America and Asia, for example CUPID, nEXO and CDEX. These projects use different isotopes and technologies to measure the decay electron energies by employing various methods to reduce background events, which means that they can be seen as complementary in some respects. With regard to LEGEND-1000, it is expected that the project's experimental setup will advance the development of ultra-sensitive detectors, cryogenic systems, low-radiation materials and innovative analysis methods. These advances could find further application in areas such as radiation detection, medical imaging, environmental monitoring and quantum computing.

In terms of **scientific utilisation**, the project benefits from a willingness to engage in broad international cooperation, particularly in Europe and with the USA. Although the research focus lies on the search for neutrinoless double beta decay, particle and astroparticle physicists are also expected to show considerable interest in the RI. A major strength of the project is its advanced RDM, which adheres to the concept of open science and FAIR principles. It is planned to make the data available to collaboration partners first and then to the public after a two-year embargo period. This approach ensures high usability standards, promotes scientific inclusivity and creates promising opportunities for utilisation. Given its convincing access strategy, its focus on high user-friendliness and its clearly structured concept for data exchange, LEGEND-1000 promises considerable benefits for the scientific community.

The project is of great **relevance for Germany as a location of science and research**: It builds on Germany's considerable expertise in key areas such as germanium technology, crystal growth and electronics. Contributions by the MPIK and TUM to the (further) development of germanium detectors used for the detection of light and particles are particularly crucial to the success of the project. The participation of German scientists in the development of key hardware components is essential for the experimental work of the project and at the same time underlines Germany's leading role in cutting-edge technologies. It is therefore to be expected that these contributions will further consolidate Germany's attractiveness and importance as a location of science and innovation.

Regarding its **feasibility from a scientific perspective**, the project benefits from experience gained in previous experiments, which provide a solid foundation for successful implementation. Most of the identified risks appear to be manageable, due in particular to a proactive and well-structured risk management strategy. One major challenge is the tight schedule, with the pending acceptance of the Technical Design Report (TDR) by the Gran Sasso National Laboratory representing a critical milestone. There is a significant scientific risk that no signal will be detected. If this occurs, adjustments to the scale of the project might be necessary, which underscores the need for flexibility throughout the entire life cycle. In view of the rapid advances in the field of neutrino physics, a certain degree of adaptability is of great importance in order to be able to react to new developments and ensure the long-term relevance of the project. Overall, the chances of successful implementation are considered high due to solid planning, robust risk management and strong institutional support.

Based on the experience from previous experiments, the collaboration is well positioned for the successful implementation of this ambitious project; the German participation is of crucial importance due to its considerable expertise in key areas such as germanium technology, crystal growth and electronics.

Against this background, the committee recommended LEGEND-1000 as one of two alternative neutrino research projects (see B.I above). By including LEGEND-1000 on the shortlist, the BMFTR has followed this recommendation.

## 1.7 PETRA IV

The ultimate 4D X-ray Microscope (PETRA IV)

Responsible institution: Deutsches Elektronen-Synchrotron (DESY)

Installation costs: approx. 1.8 billion euros

PETRA IV is the upgrade of the existing PETRA III complex at DESY, aiming to create the world's brightest X-ray source for the coming decades. The project involves replacing the current 6 GeV, 2.3-kilometre storage ring with a new one featuring a horizontal emittance of 20 pm rad. This upgrade is supposed to enable high-resolution 3D visualisation of materials in real time, providing 4D information with spatial resolution down to the atomic level. The new facility intends to serve as an 4D X-ray microscope for biological, chemical, and physical processes, supporting both academic and industrial research. The project's capabilities aim at advancing AI-assisted materials design and drug discovery, providing high-precision data to fuel ML and AI models. The aim is to enable a shift from empirical approaches to knowledge-based design of novel, multifunctional materials and improved pharmaceuticals.

### *Assessment*

With its planned X-ray source, which offers 500 times greater brilliance of high-energy photons, PETRA IV stands out for its exceptional **scientific potential**. The planned 4D imaging of larger samples with atomic resolution and the significantly improved temporal resolution of dynamic processes will enable numerous new research questions to be answered. Furthermore, the development of AI-based models built on generated high-quality data is a central goal that promises significant progress in materials design and drug development. The multidisciplinary orientation of PETRA IV addresses a wide range of scientific fields – from fundamental physics to applied materials research and biomedical research. By integrating state-of-the-art accelerator technologies, PETRA IV has the potential to significantly expand the boundaries of X-ray science and enable real-time, in-situ and operando measurements on the nanoscale. This opens up new perspectives for the investigation of complex systems under realistic conditions.

The **scientific utilisation** concept of PETRA IV is impressive due to its precise identification of the relevant user groups and its strategic focus on the versatile application possibilities of the services offered. PETRA IV addresses a broad and interdisciplinary user community from science and industry and offers new user groups open access to an innovative RI. The exceptionally large and high-quality

data sets generated by experiments can provide valuable information for stakeholders in science, clinics and industry, thus representing outstanding added value for these sectors. The integration of AI-based analysis tools makes complex experiments accessible to a broader spectrum of users and specifically promotes the transfer of knowledge between fundamental research and application-oriented science.

The expansion of PETRA IV is of essential **relevance for Germany as a location of science and research**. This includes the effort to secure and further develop international competitiveness of Germany and Europe in key future fields such as semiconductor technology, climate protection, sustainable mobility and precision medicine. The project has the potential to significantly advance innovation in key industries and strengthen scientific and industrial cooperation. Due to its globally unique technology, PETRA IV is expected to increase the attractiveness of Germany as a location of science for international researchers and make a decisive contribution to securing Germany's leading position in the field of X-ray analysis in the long term. In addition, PETRA IV can promote the competitiveness of Germany and Europe in science and technology and initiate new, interdisciplinary and international cooperation networks. According to current plans, PETRA IV is expected to be the most brilliant synchrotron radiation source in the world when it starts operating, competing with only a few other international facilities. Within the national and European research landscape, PETRA IV complements X-ray free-electron lasers (XFELs) such as European XFEL and FLASH, as well as other photon sources such as BESSY III and, in the future, DALI (see B.I.2). Together, they cover the entire demand for accelerator-based photon sources. PETRA IV will play a key role in the European LEAPS network and make a significant contribution to securing Europe's leading role in the use of high-brilliance synchrotron radiation. These unique features make PETRA IV an indispensable tool for cutting-edge research and innovation in Germany and Europe.

The draft proposal demonstrates both the ambitious scope of the project and the careful planning that has gone into it, which suggests a high degree of **feasibility from a scientific perspective**. Despite the high complexity of the project, DESY's extensive experience in operating large FELs such as the European XFEL is a particular confident factor for a successful implementation. During the conversion phase, the existing PETRA complex is expected to be out of operation for about two years ("dark phase") and will therefore not be available to users. The comparatively high estimated costs are proportionate to the scientific potential and are justified by the transformative benefits for research, industry and society.

Overall, PETRA IV combines excellent scientific potential, outstanding user orientation and strategic national relevance. With implementation planned for 2030, DESY is sending a clear signal about the future viability of Germany as a

location of science and research. Against this background, the committee recommended PETRA IV. By including it on the shortlist, the BMFTR has followed this recommendation.

## 1.8 RIDLOP

Research Infrastructure for Data from Large Online Platforms (RIDLOP)

Responsible institution: Leibniz Institute for the Social Sciences – GESIS

Installation costs: approx. 50 million euros

RIDLOP is a planned digital RI that is supposed to enable new opportunities for a wide range of research on the role of Large Online Platforms (LOPs) in modern society. To this end, RIDLOP plans to build a data portfolio based on three different ways of acquiring data: 1) data provided by the platform providers, 2) data donations provided by platform users for scientific purposes, and 3) data collected and provided by researchers for secondary use. RIDLOP wants to provide centralised access to data from LOPs by negotiating with platform providers on the basis of the EU's Digital Services Act (DSA) and acting as a trustee for data transfer. The project intends to include a scalable computing infrastructure with a data lake for storage, archiving and retrieval as well as a virtual secure enclave for data provision and remote analysis. It is also planned to create quality-assured and permanent access modes to data from LOPs. The main target group is researchers, although there will be data products created that are of interest to journalists and the general public.

### *Assessment*

RIDLOP has the **scientific potential** to facilitate independent research into the functions and effects of LOPs on important societal issues and to enable a better understanding of the dynamics within the online sphere, e.g. with regard to disinformation, incivility and hate speech, societal fragmentation or trust in state institutions. RIDLOP can decisively advance the necessary cooperation between research and large platform operators with regard to the provision of data. The project thus promises great interdisciplinary added value for researchers from social sciences, law and political sciences as well as computer science. The draft proposal focusses primarily on data access, as ensuring this is a key challenge for the research questions addressed. However, an explanation of the primary research objectives and the methods to be used should follow in the further development of the concept. A more detailed description of the measures to ensure data quality would be desirable as well.

In terms of **scientific utilisation**, RIDLOP can meet an urgent need in the social sciences. It can be assumed that the project will facilitate research in various disciplines and thus attract a broad spectrum of users. An important user group comes from the computational social sciences, which are very interdisciplinary

in nature. RIDLOP promises to be particularly attractive for scientists at early career stages, although the training aspect should be addressed even more strongly in the further development of the project. Furthermore, the fact that a single institution instead of a consortium negotiates data access with the platform operators harbours a certain risk. The institution could be instrumentalised by the platform operators as a gatekeeper, which would counteract the declared goal of guaranteeing access to data.

RIDLOP is of great **relevance for Germany as a location of science and research**. It is an internationally unique RI that aims to close a gap in the social sciences identified by ESFRI with the goal of holistic data collection instead of collections of individual data. |<sup>26</sup> There is currently no RI in Europe that offers services such as those proposed by RIDLOP. Plans at European level for a DSA Data Access Portal were concretised by the European Commission in July 2025 and the portal has been launched. |<sup>27</sup> In the further course of the project, it is recommended that the range of services RIDLOP plans to offer is designed in such a way that it is complementary to those offered by the portal. On a global level, there are similar RIs in the USA (e.g. NIO), but RIDLOP clearly differs from them in terms of the form of data collection and the quantity and quality of the data to be provided. The integration of the necessary expertise in dealing with LOPs and their data also promises a competitive advantage. The RI therefore has the potential to increase the competitiveness and visibility of Germany and Europe, particularly with regard to the computational social sciences, and to promote research into the dynamics and information flows in the global online public sphere. RIDLOP is supported by a strong network of relevant institutions and stakeholders from Germany and Europe.

The project's **feasibility from a scientific perspective** is regarded to be positive, as the RI is supported by GESIS, a strong and established institution with extensive experience in handling social science data. In addition, the proposal includes a detailed step-by-step plan, a risk analysis and risk mitigation measures. A significant risk to feasibility lies in the potentially uncooperative behaviour of platform operators, although they have not unanimously refused access for research purposes in the past and have already created – albeit problematic – access to data through application programming interfaces (APIs). Even without the cooperation of the major platform operators, a promising operation of the RI would be possible through other data collection methods, such as data donations from users or researchers and web scraping. However, RIDLOP would lose its high standards, its uniqueness and parts of its impact. Nevertheless, the advantage of a centralised digital RI and the improved

|<sup>26</sup> European Strategy Forum on Research Infrastructures (2024): ESFRI Landscape Analysis 2024; Milan, p. 105. URL: [https://landscape2024.esfri.eu/media/coqdoq0q/20240604\\_la2024.pdf](https://landscape2024.esfri.eu/media/coqdoq0q/20240604_la2024.pdf)

|<sup>27</sup> <https://digital-strategy.ec.europa.eu/en/library/delegated-act-data-access-under-digital-services-act-dsa>

archiving of existing datasets for researchers in Europe would remain. It should also be noted that the establishment of this RI could increase the pressure on companies to implement the provisions of the DSA in a transparent and reliable manner.

The committee has recommended RIDLOP as a digital RI with a unique international position that facilitates access to LOP data for research. By including it on the shortlist, the BMFTR has followed this recommendation.

## 1.9 SCALA

### Scale-Up Green Chemistry (SCALA)

Responsible institutions: Fraunhofer Institute for Interfacial Engineering and Biotechnology (IGB) | Fraunhofer Institute for Ceramic Technologies and Systems (IKTS) | Fraunhofer Institute for Microstructure of Materials and Systems (IMWS) | Fraunhofer Institute for Applied Polymer Research (IAP) | Fraunhofer Institute for Environmental, Safety and Energy Technology (UMSICHT) | Fraunhofer Institute for Chemical Technology (ICT)

Installation costs: approx. 128 million euros

SCALA is a planned research platform for the scale-up and transfer of innovative and sustainable processes in chemistry that is supposed to serve as a long-term testing and validation infrastructure for assessing the efficiency and cost-effectiveness of chemical products and processes. Thus, it aims to address the needs of scientific researchers as well as industrial players in the chemical sector. SCALA is designed as a distributed RI set up at six Fraunhofer institutes – all part of the Fraunhofer Chemistry Alliance. The objective is to bring together and jointly further develop expertise, technologies and system components of the individual research locations in the envisaged research platform. The proposal aims at building innovative technology paths from the standpoint of energy and resource efficiency, from provision of raw materials to synthesis and materials development and then to sustainable products. Additional equipment as part of the envisaged RI are demonstration platforms, and strategic additions to existing pilot plants for chemical and biotechnological processes as well as in the field of separation and purification technologies. A shared virtual infrastructure connects the different sites and serves as research data infrastructure.

### *Assessment*

SCALA is an ambitious project that addresses the central challenges of the chemical R&D sector in Germany. The **scientific potential** lies particularly in the targeted development of new scientific findings in the fields of sustainable chemistry, circularity, climate technology and materials production. The integration of various research areas, represented by the renowned Fraunhofer

institutes involved, is aimed at bundling expertise and the targeted and efficient utilisation of technologies. Under these optimised structural conditions, the RI is supposed to enable the research and development of innovative technologies and processes, e.g. for plastics recycling or the synthesis of sustainable fuels and biochemicals. These new solutions and processes can represent a significant step towards a green chemistry. SCALA promises to help close the gap between fundamental and applied research at German universities as well as research institutions and the commercial activities of the industry. The planned use of AI tools in process development is an aspect that requires further elaboration.

The opportunities for **scientific utilisation** of SCALA are convincing, as the RI is intended to meet the demand for demonstration and pilot plants for new technologies and processes at Technology Readiness Levels (TRLs) 5 to 8. SCALA is therefore of interest to scientists whose institution does not maintain its own comparable facilities, as well as to researchers from industry, small and medium-sized enterprises and start-ups who are restricted in their research for cost reasons and risk considerations. With regard to the thematically and locally neighbouring Center for the Transformation of Chemistry (CTC), which is currently being set up, SCALA would have to meet its claim to design research and infrastructure in a complementary manner and not create duplicate structures. This also applies to the open utilisation of the RI, which is planned to be based on the Fraunhofer model. |<sup>28</sup> Due to high funding requirements, this could restrict access opportunities for researchers from universities. It would therefore be essential to guarantee equal and affordable access for these scientific users as well.

SCALA has the potential to make a significant contribution to the scientific support of structural change in the chemical industry towards sustainable and green processes. It is to be expected that the resources and services offered, if they are widely accessible, will significantly increase the attractiveness of **Germany as a location of science and research**. The RI promises to drive innovation in the industry and contribute to the establishment of spin-offs and start-ups. This can further increase the international competitiveness of the already strong German R&D in the field of applied chemistry. SCALA plans to concentrate its location primarily at the Middle German Chemical Triangle, which is regarded as Germany's centre of the chemical industry and will also be home to research institutes and platforms in the future (such as the aforementioned CTC, a living lab at the Zeitz Chemical and Industrial Park, and Technology Platform Power-To-Liquid Fuels [TPP]). By bundling interdisciplinary scientific expertise from the Fraunhofer institutes, combined with modern

|<sup>28</sup> The budget of the Fraunhofer-Gesellschaft is made up of a maximum of one third from institutional funding (base funding from the German federal and state governments) and at least two thirds from competitive private- and public-sector contracts: see <https://www.fraunhofer.de/en/about-fraunhofer/profile-structure/facts-and-figures/finances.html>

technological equipment and infrastructure, SCALA sees itself in a position to offer both a broader range of topics and an overarching functional network compared to these institutions.

In terms of **feasibility from a scientific perspective**, SCALA has an increased degree of complexity due to the distribution of the RI across several institutes, which requires a thorough integrative operational management. However, the Fraunhofer institutes involved have a high level of expertise with a strong track record and the ability to effectively utilise existing infrastructures. The formation of alliances between Fraunhofer institutes is already an established and promising concept. In addition, the integrative approach involving all relevant stakeholders from the chemical sector and their needs helps to enable innovations and new standards in green chemistry. The numerous planned or existing collaborations, such as with IBISBA, a pan-European RI on the ESFRI roadmap focussing on industrial biotechnology, are also very promising.

Due to the strong institutes involved and the potential to make essential contributions to the scaling up of technologies and processes in green chemistry for science and industry, SCALA was recommended by the committee as an ambitious and innovation-promoting RI. After combining the results of the three assessment strands, SCALA was not included on the shortlist by the BMFTR.

#### 1.10 SLICES-DE

Scientific Large Scale Infrastructure for Computing/Communication  
Experimental Studies (SLICES-DE)

Responsible institution: Technical University of Munich (TUM)

Installation costs: approx. 60 million euros

SLICES-DE is a digital RI for data processing and communication. The project is supposed to be the German contribution to the European initiative SLICES-RI that aims to create a digital RI on a European scale with participants from 16 countries. SLICES-DE seeks to establish an experimental platform for researchers in the domain of information and communications technology (ICT) that can be accessed remotely. The project intends to offer a testbed with a structured experiment workflow that ensures the creation of reproducible experiments. Furthermore, long-term storage of experimental data and set-ups is included. The platform is to be further developed on the basis of extensive sample experiments, the so-called blueprints. Through its modular design, the RI aims to be flexibly adaptable to different research needs and demands. It promises to enable experimental research in relevant areas such as networking and communication systems (in particular 6G networks), AI, HPC, Internet of Things (IoT), cloud-to-edge and quantum computing. The RI primarily targets German universities and research institutions working on ICT but also plans to offer different collaboration models for industrial partners.

In terms of **scientific potential**, SLICES-DE promises to create significant added value with the help of state-of-the-art hardware and software in the field of ICT research and to enable progress and innovation in relation to communication infrastructures or ICT-RI. It can be assumed that SLICES-DE will facilitate the reproducible execution of experiments under real conditions that cannot be carried out in existing general communication structures due to their inherent risks. Challenges posed by the increasing complexity and scope of communication systems as well as the increasing demands on reliability, security and efficiency can thus be addressed. The project can also facilitate research into important problems such as post-quantum cybersecurity. It is expected that SLICES-DE will lay the foundation for many future applications in areas of computer science, such as AI or the IoT, as well as other disciplines such as engineering. The potential for further interdisciplinary collaboration should be addressed in more detail as part of the further conceptualisation of the project.

In terms of **scientific utilisation**, the project is characterised by open access for users and a convincing data management plan. It responds to a considerable demand for experimental testbeds in the research community for network technologies. As a multi-use RI, SLICES-DE will be of great benefit to German and European ICT researchers and provide an alternative to existing commercial or fragmented local solutions that lack scale and flexibility. While the proposal makes the relevance and attractiveness for the ICT community clear, the attractiveness for researchers from other fields should be better explained in the further development of the project.

SLICES-DE promises to be an essential and critical RI of great **relevance** for research and the self-sufficiency and competitiveness of **Germany as a location of science and research** in the fields of communication and information technology. The project aims to close a significant gap in the feasibility and reproducibility of experiments on network and communication systems. There are currently no directly comparable facilities in the national context. At the European level, SLICES-RI aims to establish a pan-European digital RI for experimental research in data processing and communication systems, providing a framework for cooperation and exchange of resources. As part of SLICES-RI, SLICES-DE will be able to benefit from its developments, the expertise of the partners involved and the investments made to date. With a view to possible synergies with European AI and HPC initiatives, however, the existing potential could be better focussed on. In the global context, there are comparable experimental platforms in the USA, from which SLICES-DE distinguishes itself by offering more extensive services for experiment design and reproduction. SLICES-DE is already in dialogue with these platforms (e.g. Chameleon) and thus keeps pace with international developments and standards

in the field of experimental IT research. Existing commercial solutions from the USA, which globally offer scalable cloud infrastructures for R&D, have some limitations for scientific use, as they are sometimes associated with high costs and the services can only be configured and controlled to a limited extent for experimental research. Although SLICES-DE is only comparable with these commercial solutions to a limited extent, it is seen as an attractive alternative that can put Germany in a leading position in the ICT sector and represents an important and essential step towards strengthening Germany's technological sovereignty.

A successful implementation of the project is very likely. It is at a very mature planning stage and provides a comprehensive risk analysis. The expertise of the responsible consortium makes a decisive contribution to its **feasibility from a scientific perspective**. The RI is designed to be modular so that it can be adapted to new technology trends and emerging research needs. However, the management of possible hardware obsolescence or the expiration of product warranties during the operational phase could be dealt with more clearly in the further development of the project.

The committee has recommended SLICES-DE in anticipation of scientific progress and innovation, particularly in ICT research. It is an essential and critical infrastructure for securing Germany's digital sovereignty and its leading position in the fields of communications and IT. By including it on the shortlist, the BMFTR has followed this recommendation.

#### l.11 XLZD

A xenon-based low-background observatory for astroparticle physics (XLZD)

Responsible institution: Karlsruhe Institute of Technology (KIT)

Installation costs: approx. 96 million euros (German contribution)

XLZD is an international collaboration that brings together three projects in the search for dark matter and neutrinoless double beta decay: XENONnT, LUX-ZEPLIN and DARWIN. The planned RI is designed to tackle unresolved questions in fundamental physics and cosmology. This includes the nature of dark matter, which plays a crucial role in the formation of cosmic structures such as galaxies and clusters, and the fundamental properties of neutrinos, which are closely linked to the matter-antimatter asymmetry of the universe. A planned detector will employ 60 tonnes of cryogenic liquid xenon, a well-suited medium for the detection of rare particle interactions. With its capability for highly sensitive measurements, including an exceptionally low energy threshold and background level, XLZD aims to enable research on fundamental questions in physics. Through its comprehensive scientific program, XLZD intends to establish itself as a next-generation multi-purpose observatory in astroparticle physics.

The project has exceptional **scientific potential** and promises significant advancements in astroparticle physics by bringing together major efforts in dark matter and neutrinoless double beta decay detection. Currently, several multinational collaborations are working in this field to establish a next-generation detector – an observatory with extremely low background and an ambitious scientific programme focusing on the physics of dark matter and neutrinos. In this context, XLZD’s research capabilities are characterised by a broad experimental spectrum, addressing key open questions with exceptional discovery potential in (astro)particle physics, astrophysics and cosmology. Due to its design, which allows for versatile use cases and synergies with other experiments that use different detection media, XLZD is expected to provide extremely valuable data.

In terms of **scientific utilisation**, the project is expected to offer significant benefits to the national and international scientific community. Germany’s leading role in previous experiments has resulted in a user base that brings together around 250 scientists from the XENONnT, LUX-ZEPLIN and DARWIN experiments. In addition to this already established user base, the broad range of applications offered by XLZD provides opportunities for other research groups to participate. Open data access in adherence to FAIR principles is planned. While the raw data remains within the collaboration, processed analysis data will be published after an embargo period. This will promote scientific collaboration and enable the joint development of theoretical models. XLZD thus offers a well-planned data utilisation strategy, high usability standards and considerable benefits for the scientific community.

XLZD has a high **relevance for Germany as a location of science and research**. Due to the planned substantial contribution to the costs of the RI and the considerable expertise in dark matter research and low background experiments, the German participation plays a central role for the success of the project. The leading role of German researchers and institutions in the various predecessor experiments is to be regarded as an important foundation for XLZD and ensures KIT high visibility and leadership opportunities. It is therefore to be expected that this participation will contribute significantly to strengthening Germany’s long-term position as a leading international research location and emphasise its standing in the context of global research.

From a scientific perspective, the **feasibility** of the project can be regarded as very strong given its solid technological basis and realistic timeframe. The use of proven technologies from previous experiments is expected to significantly reduce the need for extensive development work. As this is a new collaboration supporting the project, there are some inherent risks. Considerable resources will be required for the planned provision of pre-processed analysis data after

the embargo period. The successful implementation of XLZD also requires close cooperation with industry at various levels.

Based on the experience from previous experiments, the collaboration is well positioned for the successful implementation of the ambitious project XLZD, with German participation playing a crucial role due to its considerable expertise in dark matter research and low background experiments. Against this background, the committee recommended XLZD as one of two alternative neutrino research projects (see B.I above) for inclusion on the shortlist. After bringing together the results of the three assessment strands, XLZD was not included on the shortlist by the BMFTR.

## **B.II ASSESSMENT OF THE ADDITIONAL PROJECTS**

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The 21 projects that were not recommended by the committee for inclusion on the shortlist are outlined below. The committee saw promising approaches and potential in many of them, meaning that the lack of a recommendation for inclusion on the shortlist should not be equated with a rejection of the ideas and concepts on which the proposals are based. Rather, the selection of a limited number of projects by the committee meant that in some cases even proposals that were rated very positively could not be considered, as other proposals were perceived to be even more promising.

### II.1 AMR

Advanced Modular Reactor (AMR)

Responsible institution: Technical University of Munich (TUM)

Installation costs: approx. 1.8 billion euros

AMR is an initiative for advancing nuclear technology, with a particular emphasis on supporting fusion energy research through high-flux fast neutron irradiation. AMR is designed as a fourth-generation research reactor with an electrical output of 30 MWe and a thermal output of 90 MWth. The plan is to use lead cooling to enable extreme irradiation environments, which are essential for materials testing under the conditions of a fusion reactor. Providing intense fast neutron beams, AMR intends to investigate radiation damage in structural and functional materials, tritium production, and transmutation. In addition to its focus on fusion materials research, AMR is supposed to support further applications such as low-emission energy supply for the campus Garching, neutron imaging, and advanced materials analysis. It also aims to contribute to the production of medical isotopes, advancing cancer diagnostics and therapy. AMR is intended to complement TUM's existing FRM II research reactor, enhancing its experimental capabilities. The concept also intends to address social, political, and ethical concerns regarding nuclear technology through

interdisciplinary collaboration with the TUM School of Social Sciences and Technology.

#### *Assessment*

With regard to **scientific potential**, AMR pursues a multifunctional approach that offers opportunities for progress in the integration of energy research, medical technology and materials science. The use of lead cooling technology and fast neutrons further promises novel research on fusion materials and nuclear fuels. However, the scientific objectives of the project are not defined with sufficient precision. In particular, the relationship between research and isotope production needs further clarification – an aspect that is of central importance for the classification of AMR as a research facility. Although the ambitious vision of a reactor-based neutron source with valuable goals in research, radioisotope production and the development of advanced reactor technologies can be highlighted, the concept lacks a concrete discussion of current scientific challenges and prospects of specific contributions to future scientific developments. International competition – for example, from advanced projects such as the Jules Horowitz Reactor in France or the MYRRHA project in Belgium – must be taken into account in the design of a research reactor, as must the fact that essential reactor technologies will have to be imported.

AMR's **scientific utilisation** concept addresses a broad spectrum of users, from nuclear physicists to medical researchers, but there is no convincing strategy for involving external scientists and industrial partners. Although the potential for nuclear technology research exists, the competitiveness of neutron scattering experiments compared to FRM II is considered doubtful. The extent and possibilities of academic participation and access for external users also remain unclear. The potential for international usability is also perceived critically, particularly in view of competition from spallation sources and HiCANS.

AMR has the potential to contribute to maintaining nuclear expertise in **Germany as a location of science and research** – particularly against the backdrop of the nuclear phase-out – and to strengthen strategically important areas such as medical technology and energy research. The planned educational initiatives, such as the establishment of new professorships and a Master's programme, can counteract the current shortage of skilled professionals in relevant areas. However, questions remain regarding the prospective direction of energy policy and public acceptance. Although the relevance of AMR as a source of fast neutrons can be emphasised, the existing international competition and the commercial nature of the radioisotope market must also be pointed out. The draft proposal does not sufficiently outline the relationship between scientific and economic motivations.

**From a scientific perspective**, the **feasibility** of the project raises questions. Despite the expertise available at TUM, there are concerns about the complexity, costs (especially in comparison with similar projects) and timetable. The planned completion date of 2034 is considered unrealistic, and the budget is disproportionate to the scientific added value. Furthermore, regulatory hurdles and political conditions in Germany are not sufficiently taken into account. The institutional requirements also raise doubts about the feasibility of the project, especially given the lack of experience with the construction and operation of lead-cooled fast reactors and the complex approval process for new nuclear technologies. The weak risk analysis and the lack of a convincing financial concept are also cause for criticism. The latter should take sufficient account of the costs of construction, operation and dismantling, but also put them in an appropriate relation to the scientific added value. A more detailed examination of the scientific and technological challenges and a clearer presentation of the risks and implementation strategies are strongly recommended in the event of further development of the project.

## II.2 DZTO

Deutsches Zentrum für Translationale Organoidforschung (DZTO)

Responsible institutions: Technical University of Munich (TUM) | University Hospital Rechts der Isar (TUM Hospital)

Installation costs: approx. 169 million euros

The German Center for Translational Organoid Research, the DZTO, is planned as an interdisciplinary research and service hub that brings together experts from various disciplines such as natural sciences, life sciences, bioengineering and medicine, operating as a virtual centre with the goal of translating organoid technology into clinical applications. The goal is to establish a harmonized platform infrastructure, with the TUM Center for Organoid Systems (COS) acting as the coordinating institution. DZTO aims to provide services such as standardised protocols and platforms for organoid research, support for organoid-based clinical trials, a Germany-wide Biobank, high-throughput drug screening and core facilities for organoid-based translational research.

### *Assessment*

DZTO has the **scientific potential** to make organoids usable for preclinical research and to promote interdisciplinary and transdisciplinary collaboration between relevant fields of research. The harmonisation of organoid protocols and the development of a virtual hub promise to be distinctive features. The importance and relevance of interdisciplinary research into the development and use of organoids are undisputed. However, given the currently limited usability of organoids for certain diseases such as cancer, DZTO's goal of using organoids in clinical trials is still a long way off. The concept would benefit from

greater clarity regarding the overarching objectives, distinctive features as well as planned structures and processes, e.g. with regard to the clinical trials to be conducted or the planned biobank. Establishing a large RI in line with the prioritisation process cannot be sufficiently justified by DZTO's main objective of harmonising organoid protocols. Further differentiation of key details of the research programme and a focus on the first steps in organoid research rather than on its application would be necessary to make the project more convincing.

The **scientific utilisation** of DZTO is promising for preclinical research and potentially for the pharmaceutical and nutrition industries. In addition, DZTO has the potential to establish a unique and useful biobank for a wide variety of diseases and genetic material, provided it cooperates with hospitals and national collections. The data management concept as described is sound. The potential usability of DZTO is limited by the fact that it remains unclear what the specific barriers to interdisciplinary and transdisciplinary collaboration are that DZTO intends to promote. Furthermore, it remains unclear whether there is a real need for a virtual hub in research communities.

As organoid research is an extremely important field of research at present and will continue to be so in the future, DZTO can increase the attractiveness of **Germany as a location of science and research** for researchers from abroad. However, there are doubts about DZTO's claim to be a leading centre of excellence with global appeal due to strong competition from international research centres and institutions in the field of organoid research. Extensive use of DZTO beyond Germany is therefore considered as less likely.

In terms of **feasibility from a scientific perspective**, the current technical possibilities in organoid research pose a major challenge for the scientific goals of DZTO, especially for application in clinical trials. Modelling diseases with organoids is currently possible for a few selected conditions, but widespread application is likely to take decades, which makes it difficult to adequately fill the research pipeline. Another major challenge concerns legal regulations that are likely to hamper the clinical application of organoids. The scientific milestones are not formulated convincingly in the draft proposal. In view of the difficulties expected in standardising protocols and the necessary links to hospitals, it remains unclear whether the institutional requirements for achieving DZTO's objectives are adequately met.

## EBRAINS Deutschland (EBRAINS-D)

Responsible institution: Forschungszentrum Jülich (FZJ)

Installation costs: approx. 76 million euros

EBRAINS-D is a planned distributed RI that aims to advance the understanding of the structure and function of the brain by leveraging AI and powerful computational resources. Through digital services, including a central web portal, it intends to provide access to self-trained foundation models and application workflows as well as a collection of large multiscale, multimodal datasets of the human brain. The RI aims to provide added value for applications such as drug development, multiscale brain modelling, clinical treatment of neurological and mental disorders, deep home-based phenotyping, AI, neuromorphic computing and robotics. For that purpose, EBRAINS-D is supposed to include hardware infrastructure such as HPC and cloud computing, neuromorphic computing as well as storage resources and a secure data processing environment. Through its scanning facilities, it intends to create imaging data, brain atlases and digital twins of the brain that will form the basis of the foundation models, which are the key element of the RI. EBRAINS-D is planned as partner and national node of the federated European EBRAINS RI, an ESFRI project that is providing data, models, and services to users across Europe.

### *Assessment*

In terms of **scientific potential**, EBRAINS-D is expected to add value to the neurosciences by improving our understanding of the functioning of the brain. The project builds on achievements and experience from previous or existing projects such as the Human Brain Project (HBP) and EBRAINS and represents a promising further development. The project has the potential to promote research in the neurosciences and contribute to scientific breakthroughs. The endeavour to link structural and functional data appears particularly promising, although this could be explained in more detail in the draft proposal. EBRAINS-D promises many applications in several disciplines such as computer science, engineering or medicine and has a high potential for interdisciplinary collaboration, although this is partly not specified in detail. The draft proposal includes many innovative or niche developments from computer science, such as the proposed integration of AI through the construction of foundation layers or neuromorphic computing, whose role in the development of the RI and for the achievement of its goals should, however, be better presented.

In its **scientific utilisation**, the project meets the needs and ambitions of the neuroscience community and is expected to generate high demand in Germany – and possibly in Europe. EBRAINS-D plans to follow the FAIR principles, and the plans for data access and management are exemplary for the

neurosciences. However, access to the raw data generated is not clearly assured in the draft proposal. The availability of scanning facilities promises significantly improved access to brain imaging data. In view of the criticism of the previous HBP project, a too narrow focus on the neurosciences in Germany and an insufficient approach to users from other disciplines or countries is detrimental to the project's persuasive power.

There is no doubt that EBRAINS-D is of high **relevance for Germany as a location of science and research** and its competitiveness as a centre of neuroscience research. The project would secure access to cutting-edge technologies for the neuroscience community, and it can be expected to increase the attractiveness for top talents from the neurosciences. EBRAINS-D plans to make a significant contribution to the European EBRAINS-RI with its scanning facilities and the AI foundation models. However, cooperation with the European initiative and the relationship with the HBP should be addressed more closely in any further development of the project.

EBRAINS-D is characterised by a strong consortium of internationally well-connected partner institutions that have the technologies and computing capacities required for implementation. From a neuroscientific perspective, the targeted improvements in the imaging data are also achievable. There are some concerns regarding the **feasibility** of developing Ecological Momentary Assessments (EMA), for which the project would have to involve industrial partners with experience in the development of medical products in Germany. A central problem lies in the AI foundation models due to the focus more on their application than on their structure in the draft proposal. The planned development of foundation models appears neither realistic nor efficient within the given time frame and budget. A more feasible alternative, which was not considered, would be the acquisition of basic foundation models that could be customised for the use of the RI. The ethical challenges to be addressed in this context are not adequately referred to, as solely compliance with regulations is mentioned.

#### II.4 EST

European Solar Telescope (EST)

Responsible institutions: Institute of Solar Physics (KIS) | Leibniz Institute for Astrophysics Potsdam (AIP)

Installation costs: approx. 61 million euros (German contribution)

The EST is a planned European solar observatory with an aperture of 4.2 meters that is able to capture spectral and polarimetric data simultaneously. This capability aims for the detailed reconstruction of the Sun's three-dimensional atmosphere, disentangling spatial, spectral, and temporal variations. The EST features sophisticated instruments, including integral field spectropolarimeters

and tuneable narrow-band filters, developed in part by German research institutes. Its design incorporates a multi-conjugate adaptive optics system to optimize performance. By combining multi-wavelength and polarization observations, the EST will study the thermal, dynamic, and magnetic properties of plasma across different solar atmospheric layers. This should significantly improve our understanding of solar magnetic activity with implications for stellar astrophysics and space weather. Supported by a Europe-wide consortium, the EST is part of the ESFRI Roadmap and currently in the preparatory phase.

#### *Assessment*

The project has high **scientific potential** and complements existing facilities such as DKIST in Hawaii in several key aspects. Optimized for polarimetric sensitivity and high-resolution observations, the EST is specifically designed to study the lower layers of the solar atmosphere, enabling detailed investigations of small-scale solar processes. Its advanced capabilities in magnetic field measurements and precise spectro-polarimetry are crucial for tracking solar eruptions and understanding their impact on Earth. The EST is expected to make an important contribution to research on plasma dynamics, solar magnetic variability and the fundamental processes driving solar activity. The telescope is intended to provide unique insights into energy transfer and magnetic coupling in the Sun's atmosphere, thereby positioning itself at the forefront of solar and stellar physics. It is expected that this will complement space-based observations and advance our understanding of space weather.

With regard to **scientific utilisation**, the intention is to provide the scientific community with access to valuable data while adhering to established data management standards. The implementation of the RUCIO data management system is intended to ensure data compatibility and support opportunities for global collaboration. Adherence to the FAIR principles is also intended to ensure long-term accessibility. After an embargo period, the data collected are planned to be integrated into PUNCH4NFDI, a consortium of the NFDI that promotes the long-term storage, secure exchange and efficient use of data from (astro)particle physics, hadron and nuclear physics, and astronomy. Due to the planned embargo phase, direct comparative analyses with data from other observatories, such as DKIST, appear to be limited. Against this background, effective data management will be crucial to maximise the global impact of the project.

In terms of the **relevance for Germany as a location of science and research**, the RI is expected to significantly strengthen Germany's position as a key player in the field of solar physics. German institutions play leading roles within the project and, due to their considerable expertise, are able to make a significant contribution to the development of instruments. By participating in the EST, KIS and AIP, as German players, are able to visibly advance technological innovations in Europe and at the same time contribute to addressing critical challenges, such as the impact of space weather on Earth.

Regarding the **feasibility from a scientific perspective**, the project is characterised by solid planning and continuous progress in the areas of design and development. It is therefore very well positioned for successful implementation. The technological aspects are well aligned with the scientific objectives of the project. While important groundwork has already been completed, there are still some minor gaps in the planning of milestones and risk management, which makes a detailed assessment of these points difficult. Heat management, which is a central and recognised focus due to the scaling problems typical of large solar telescopes, is not expected to be a major challenge. The project benefits from robust management structures and a clear commitment to addressing risks effectively. Provided that support remains consistent and plans are refined, the EST is well positioned to achieve its ambitious goals within the scope of current technological capabilities.

## II.5 FlexiPlant

Research infrastructure for the adaptive processing of complex raw materials (FlexiPlant)

Responsible institution: Helmholtz-Zentrum Dresden-Rossendorf (HZDR)

Installation costs: approx. 109 million euros

FlexiPlant plans a pilot-scale prototype of a flexible processing system aiming at a knowledge-driven, networked, digitalised and agile recycling industry that is supposed to be able to extract all sustainably recoverable raw materials from every end-of-life product. A special focus lies on the recycling of all types of waste electrical and electronic equipment as well as their primary and secondary products. The aim is to close material loops and enable a sustainable circular economy. FlexiPlant is designed to combine conventional shredding and separation equipment via a flexible routing system that allows the individual machines to simultaneously process various materials in any order, and multiple times. Newly developed, particle-based multi-sensor systems and control algorithms, in combination with flexible routing, should enable optimum processing for each material flow. These algorithms are based on particle-accurate material flow characterisation, phase- and structure-accurate material and process models, stochastic optimisation as well as ML and AI.

### *Assessment*

The concept of a flexible and fully automated pilot plant with a focus on rare minerals and innovative waste sorting technologies, as well as the RI's interdisciplinary cooperation opportunities are promising and demonstrate **scientific potential**. This puts FlexiPlant in the position to contribute to the important field of recycling and processing materials through the expected diverse and interrelated research. However, given the existence of analogous facilities that already make their specialised structures and processes available

for research purposes, it remains unclear how the integration of the stated technologies and stakeholders into a centralised facility can offer significant additional value and innovation to the field. It is further questionable whether the proposed flexibility of the processing system is achievable and adequate for the stated uniqueness of the RI. The proposal declares capabilities in various subject areas in an extensive and open manner, which raises the question of appropriate specification of the project's main goals towards specific subject areas and associated research questions. The proposal would benefit from a stronger, more specific focus on certain aspects, sub-areas and measures.

FlexiPlant has assembled a diverse set of stakeholders with complementary expertise and strong partners. Regarding the **scientific utilisation**, this enables promising opportunities for different target groups from both science and industry to access the RI and participate in its developments. However, the access and usage model remain superficial and it is questionable whether the RI can be used effectively by research communities from the diverse fields of process engineering, device and system developing or transdisciplinary research. The proposal would benefit from a more comprehensive description of scientific and commercial use and of the amount, types, and use of generated data.

FlexiPlant addresses problems of high **relevance for Germany** and international actors. Especially the availability of and access to rare minerals for supply chains is a topic of strategic importance. FlexiPlant seeks to contribute to finding solutions for securing such valuable supplies. Germany already has a notable position in the recycling industry and FlexiPlant has the potential to further enhance this position. Furthermore, the RI can be expected to have a noticeable national impact, which may include the promotion of further political as well as societal endeavours in the area of circular economy. Specifying the project's position and uniqueness from an international perspective and including other national research institutions in the field would further strengthen the proposal.

The draft proposal shows sufficient institutional conditions for the planned endeavours and the **feasibility from a scientific perspective**. The RI's practical applications are well-presented especially from an engineering perspective. However, the technical details and the envisaged mode of operation are described in general terms; further details would be helpful to assess their feasibility and the proposed measures' suitability. It remains unclear how the RI will operate in practice. Digital tools such as AI and ML also could be discussed in more detail regarding their nature and implementation. Additionally, FlexiPlant's installation phase spanning over seven years appears long given that results can be achieved sooner and the technologies are available. In light of the rapid change and quick obsolescence of technological developments, the proposal would benefit from a more robust risk analysis with regard to R&D requirements.

NMR high-field spectrometer for bio- and materials science (Future-NMR)

Responsible institutions: Goethe University Frankfurt (GU) | Max Planck Institute for Multidisciplinary Sciences (MPINAT) | Technical University of Munich (TUM) | Helmholtz Munich (HMGU)

Installation costs: approx. 101 million euros

Future-NMR aims to establish ultra-high-field NMR spectrometers with a magnetic field strength of up to 35.5 T for advanced high-precision structural analysis in bio and materials research. The proposed RI involves three NMR spectrometers with complementary areas of application: A 1.4 GHz spectrometer for biological research will be installed at the GU, a 1.5 GHz spectrometer for solid-state analysis at the MPINAT, and a 1.4 GHz multifunctional spectrometer for the analysis of solids and liquids at the HMGU and TUM. Each of these spectrometers is also supposed to be capable of performing magic-angle spinning (MAS) spectroscopy, enabling detailed solid-state analyses. The RI is intended to be embedded into the existing national and European research landscape, through its inclusion in Instruct-ERIC, a landmark on the ESFRI roadmap. Future-NMR wants to focus on five key research areas: the research and development of novel catalyst systems, charge and mass transport in energy materials, innovative drug development, 4D structural biology and the characterisation of heterogeneous macromolecular systems.

#### *Assessment*

In terms of **scientific potential**, Future-NMR has a forward-looking design that promises good conditions for scientific progress and in-depth insights into molecular structures and dynamics. The focus is on the construction of three interdisciplinary high-field NMR spectrometers at different locations for specific applications. The project thus promises to provide impetus for numerous life science research fields, such as biological and health sciences, materials and environmental sciences, as well as considerable innovation potential for sustainable energies, battery technologies, drug development and materials engineering. The interdisciplinary approach of the project is expected to lead to scientific progress particularly in structural biology and translational research. However, there are shortcomings in the integration of materials science expertise, which means that the potential of this field is not being fully exploited. Moreover, the scientific added value of the planned frequency increase to 1.5 GHz remains insufficiently demonstrated. A convincing presentation of the resulting knowledge gain and the specific research questions that can only be addressed using this novel frequency range would be conducive to justifying the considerable technical and financial investment.

Future-NMR pursues a broad-based, interdisciplinary **scientific utilisation** concept that enables the effective integration of a wide range of life and materials science disciplines. The expected demand and planned utilisation capacities suggest high relevance for a broad user group. The projected participation of around 30 European user groups per location per year appears plausible and underlines the potential use of the infrastructure. The interdisciplinary nature of the RI is particularly advantageous for exploring new research questions, even if the geographical distribution of the three facilities poses challenges. The need to set up three new systems at different locations is unclear, especially in view of the access strategy, which has not been fully explained. In addition, there are potential technical risks that may arise from the complexity and coordination of the facilities. For better utilisation, a stronger methodological focus on operando studies and the necessary technologies would be advisable. The project offers good conditions for efficient data management based on existing systems, which can enable effective use of the instruments. The planned connection to the Instruct-ERIC cloud platform is expected to further strengthen accessibility and cooperation.

The project has great potential to have a national, European and global impact through the innovative systematic integration of biological and materials sciences via NMR technology. Future-NMR promises positive effects for **Germany as a location of science and research**, as the innovative approach can significantly increase Germany's international visibility. The close cooperation between two leading universities, a Helmholtz Centre and a Max Planck Institute opens up opportunities for significant advancement of NMR research. The participating institutions already have an international presence in the life sciences; a joint infrastructure could strategically consolidate and expand this position. The project therefore has high scientific and strategic relevance, which can strengthen Germany's international visibility in the research landscape. The interest of European and international partners, confirmed by numerous letters of support, indicates considerable development potential. Future-NMR can thus strengthen Germany's competitiveness in NMR research.

Regarding **feasibility from a scientific perspective**, the concept is likely to be successfully implemented. Overall, Future-NMR offers good conditions for establishing itself as a technologically and logistically viable RI. In addition, the participating institutions possess extensive experience in setting up and operating comparable infrastructures. The draft proposal comprises clearly defined goals and realistic milestones that will enable structured implementation. Current technological developments indicate that the novel 1.5 GHz systems could be available within the next three years. Sustainable measures such as helium recovery systems also contribute to long-term operational safety. However, the limited involvement of materials science expertise to date, combined with an unclear presentation of the added scientific value of the 1.5 GHz frequency increase, proves to be a limiting factor, so that

the considerable effort involved in the project does not yet appear to be fully justified.

## II.7 GRICE-NET

German Research Infrastructure Network for Cell-Based Medicine (GRICE-NET)

Responsible institution: Charité – Universitätsmedizin Berlin

Installation costs: approx. 233 million euros

GRICE-NET plans to establish a large, interdisciplinary research network across Germany with ten key locations and Berlin as its central hub. It aims to provide access to production, research facilities and all necessary services and expertise to rapidly develop new therapies and diagnostics in the field of cell-based therapies. This is to be achieved by combining innovative single-cell technologies and ATMPs. GRICE-NET plans to offer its services through streamlined processes and clinical validation. The infrastructure comprises scientific, technical, and structural layers, and the construction of two new buildings in Berlin. The core institutes and partner sites serve as specialised nodes with infrastructural capacities and services, including rooms, labs, or computing. Different access modalities are intended to be developed for academia, industry, and society as potential user groups.

### *Assessment*

In view of the **scientific potential** as well as national significance of gene- and cell-based therapies, GRICE-NET is a forward-looking and complex initiative with its planned establishment of a large research network for cell-based medicine. Its added value is particularly evident in the planned application of identified ATMPs in clinical trials, the speed of these processes, the proximity to patient groups and the use of single-cell diagnostics for monitoring diseases. The expertise of the parties involved is interdisciplinary and promising. Despite Charité's undoubted expertise in single-cell diagnostics, however, questions remain regarding the applicability of this technology in various disease areas and the practical implementation of its clinical benefits. As a considerable portion of the estimated funding is to be invested in the construction of buildings in Berlin, the question arises as to how this fits in with the goal of establishing a nationally distributed network. There is a contrast here between the investment in a central node – Berlin – in relation to the other national nodes.

With regard to **scientific utilisation**, GRICE-NET offers standard access options and utilisation standards for various users from research (e.g. oncology, immunology or regenerative medicine), industry and society. The potential access to GRICE-NET's ten network nodes for the use of developed technologies is particularly valuable. Specifically, the development unit for cell-based

medicine also offers high utilisation value for both German and European researchers. However, the process of guiding users to the nodes and providing the relevant services should be further clarified, particularly with regard to a well-founded estimate of user numbers. Given GRICE-NET's focus on the nodes and specifically on the central node in Berlin, the project would benefit from emphasising inclusion for external parties outside the network, both in Berlin and in the other nodes. In this way, GRICE-NET would attract a higher number of external users.

Given the strong competition in cell-based medicine from international players, GRICE-NET promises to significantly improve visibility of **Germany as a location of science and research** as well as its position in this field. Against the backdrop of German and European legislation, GRICE-NET is an ambitious project, as there are major challenges involved in standardising the ATMP landscape. The proposal would benefit from highlighting the scientific contributions made by the RI outside of Berlin.

In terms of **feasibility from a scientific perspective**, the concept is characterised by very mature planning, convincing risk analyses and strategies for dealing with these risks. The project fulfils the basic institutional requirements for the successful implementation of the plans. However, given the scale involved in establishing such a network in the long term, it would benefit from more detailed explanations of the governance, structure and decision-making processes within GRICE-NET. The limitations of the current use of ATMPs in medical treatments as well as challenges in identifying ATMP targets and in the use of AI also require closer consideration.

## II.8 GUF1-14T

German Ultra-high-field Imaging 14 Tesla MRI Center (GUF1-14T)

Responsible institution: Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU)

Installation costs: approx. 85 million euros

GUF1-14T aims to enable whole-body MRI in humans at the very high magnetic field strength of 14 T. In this way it aims to open new avenues for investigating physiological and pathophysiological processes across various biomedical research areas. This includes both basic neuroscientific research as well as clinical research in areas such as neurodegenerative diseases, cancer, and immunological diseases. The facility is planned to be housed in a new building at FAU in Erlangen, in close proximity to one of its major industry partners, Siemens Healthineers. GUF1-14T is designed as a jointly coordinated and open facility that aims to provide access based on the scientific quality of research proposals. 13 member institutions and affiliated partners of the German Ultra-High-Field Imaging (GUF1) Consortium support the infrastructure.

GUFI-14T stands out in terms of **scientific potential** through its sophisticated, highly innovative and convincingly presented concept. Due to technological improvements in image resolution, GUFI-14T promises to enable whole-body scans to be carried out for research into a wide range of diseases. The project is well suited to interdisciplinary collaboration; the responsible, cross-institutional consortium enables GUFI-14T to increase the potential for cooperative breakthroughs. However, the scientific questions and main objectives remain unclear in some respects. For example, it is questionable whether higher image resolution is the most promising way to achieve scientific discoveries in imaging techniques. The question also arises as to why a magnetic field strength higher than 14 T is not being targeted. The medical need and the progress expected from imaging at 14 T would have to be argued more convincingly, especially in view of other current technological advances made possible by the use of AI. Greater consideration of the scientific achievements of international high-field MRI facilities would further increase the scientific potential of the concept.

GUFI-14T is expected to enable **scientific utilisation** by a diverse community. The data management concepts are committed to the FAIR principles and are appropriate. However, the draft proposal should place a stronger focus on improved accessibility for users outside the consortium. Given the large data volume generated by imaging facilities and the importance of sustainable data use, the draft proposal would benefit from more detailed explanations regarding data utilisation. The question of utilisation must be answered against the backdrop of current technological progress, which is rapidly rendering current technologies obsolete.

In view of its **relevance for Germany as a location of science and research**, GUFI-14T has the potential to strengthen Germany's position as the world leader in the field of high-field imaging, given the ambitious nature of the project and the technological advances it represents. The project further has the potential to increase Europe's competitiveness in MRI research and redefine standards. Cooperation with the Dutch 14-Tesla MRI initiative at Radboud University and membership in EuroBio-Imaging, a European RI in the field of imaging, would be beneficial to the project, but are not described in further detail in the draft proposal. Although the construction of GUFI-14T is desirable from a European perspective, the question of its necessity and the scope of utilisation particularly within Germany remains.

In terms of **feasibility from a scientific perspective**, the technical planning of GUFI-14T is essentially mature and convincing. While technical requirements are very well presented in the draft proposal, no detailed descriptions specific to scientific implementation and utilisation processes are provided. The project involves a considerable "high-risk, high-reward" ratio, which requires further planning to minimise risk.

## The Karlsruhe Nuclear Magnetic Resonance Facility (KNMR)

Responsible institution: Karlsruhe Institute of Technology (KIT)

Installation costs: approx. 160 million euros

KNMR envisages a facility for advanced characterisation of materials using high-field superconducting NMR magnets with a power of up to 35 T. This facility is supposed to feature six experimental platforms and provide a fully digitised analytical environment for materials science research. The RI intends to focus on quantum mechanical structures, chemical synthesis and operando behaviour in dynamic processes, addressing challenges at the interface between research and industrial applications. By incorporating deep learning capabilities, KNMR aims to improve the digitalisation of material information, allowing the system to autonomously control and interpret experiments and to learn from them. The focus will be on research into clean energy, sustainable chemical production and rapid response to global crises, among others. As a result, KNMR strives to develop into a competence centre for the fields of energy, information, environment, pharmaceuticals and materials.

### *Assessment*

In terms of **scientific potential**, KNMR is a highly specialised, application-oriented RI that aims to address key issues in materials research and synthesis using innovative NMR technologies. It offers a wide range of opportunities for the further development of materials science, particularly in the fields of sustainable energy technologies and sustainable chemistry. The intention to cover multiple stages of the knowledge chain, link different analysis techniques and provide an integrated solution at a single location is promising. With a clear focus on materials characterisation, operando analytics and hardware development, KNMR has potential for innovation and interdisciplinary collaboration. Due to its thematic specialisation, it offers promising prospects for advancing materials science in a decisive manner. Due to this focused approach, the project demonstrates high innovative potential and the capacity to sustainably strengthen analytical materials research, while further enhancing Germany's scientific visibility in this field. At the same time, it appears likely that the planned focus may limit the range of potential applications beyond materials science and constrain interdisciplinary approaches.

The project stands out for its high user-friendliness and offers the targeted research community, particularly in materials science, an innovative concept for **scientific utilisation**. It outlines clear plans for access modalities and data management with the aim of establishing a fully digitalised materials science facility. KNMR's holistic operando approach opens up great potential for a comprehensive utilisation of the RI and for the targeted involvement of research

groups and early-career researchers. The planned embedding of digital technologies offers new methodological perspectives and promises to broaden the range of applications of the RI. Nevertheless, the high degree of specialisation of KNMR and the associated training requirements could significantly limit access for a broader user base, especially outside the field of materials science. In order to fully exploit the potential for use, more concrete information on practical implementation, especially with regard to open access for user groups outside KIT, would also be desirable.

With regard to its **relevance for Germany as a location of science and research**, KNMR promises to provide sustainable impetus for materials science in the long term and make a decisive contribution to strengthening Germany's attractiveness and international competitiveness. The project is promising given the depth and scope of its unique approach to materials science, as an RI of this magnitude has not yet been realised in this field. In global comparison, KNMR has the potential to compete with renowned high-field magnet laboratories. This opens up a strategic opportunity for Germany to significantly expand its position in global NMR research.

Overall, the project's **feasibility from a scientific perspective** can be considered realistic due to the sound planning framework and institutional support. The concept of bringing together the entire materials science knowledge chain in one place is both highly innovative and ambitious. The project is supported by the proven expertise of the responsible institution KIT and can be expected to be successfully implemented. However, the highly innovative nature of the RI also poses potential challenges, such as compliance with the planned timeframe and legal requirements, as well as the impact of machine failures on the operation of the RI. These risks are addressed in the draft proposal, but there is potential for more detailed elaboration. In addition, the planned digitalisation of the infrastructure should be further specified.

## II.10 LARC

Large Animal Research and Care Center (LARC)

Responsible institution: University of Bonn (U Bonn)

Installation costs: approx. 88 million euros

LARC aims at advancing translational medical research and promoting agricultural sustainability with an emphasis on animal welfare. The project is planned as an interdisciplinary research hub with the goal of making large animal research more accessible and optimising study designs. LARC pursues research objectives across three overlapping disciplines: agricultural sciences, veterinary science and translational medicine. To this end, LARC is to be established as an independent organisational unit within the Faculty of Medicine and the Faculty of Agriculture, Nutrition and Engineering at the

University of Bonn. The project is intended to include building infrastructure facilities such as lab space, examination rooms, imaging facilities, stables and pasture areas, as well as personnel structures such as animal care takers, scientists, and veterinarians.

#### *Assessment*

LARC shows **scientific potential** to become a strong research centre. Given the relevance of research questions on sustainable nutrition and the use of farm animals in biomedical research, there is undoubtedly a need for such an interdisciplinary and transdisciplinary institution. However, the draft proposal would benefit from a more precise scientific programme and further details on experimental issues, capacity and flexibility of the facilities. Given the focus on translational medicine, it is necessary to harmonise the networking of the disciplines involved, including the field of animal welfare, and to pursue greater cooperation at national and international level.

In terms of **scientific utilisation**, LARC offers great value to users in agricultural and veterinary research, biomedicine and translational medicine through its planned large animal research. The concept of LARC as a user-oriented centre and service platform is particularly noteworthy. The intended RDM and the commitment to open access regulations are sound. However, it is questionable whether there is sufficient expertise at the University of Bonn to attract and support internal and external users. Given the lack of a user needs analysis that takes into account other national and international animal research facilities, the basic modalities of access and utilisation remain unclear. In view of the fact that other research institutions in Germany are already conducting large animal research in similar areas, opening up LARC to external users to a considerable extent would be a favourable and essential infrastructural feature.

Since only a few other institutions worldwide combine agricultural sciences, veterinary science and translational medicine in an interdisciplinary manner in one location, a project such as LARC has the potential to contribute significantly to the attractiveness of Germany as a location of science and research at the interface of these scientific fields. The demand for farm animals in biomedical research, the advantages of large animals for disease models, and the importance of research questions on sustainable nutrition and climate change enable LARC to attract global cooperation partners.

In terms of **feasibility from a scientific perspective**, the overall planning for the establishment and organisation of LARC is well described and the risk analysis indicates careful implementation. The plans submitted as well as the scientific and administrative setting generally indicate that the institutional conditions for the project are adequate. However, scientific milestones, measures to minimise risks for ethical and administrative challenges in view of the uncertain future of animal testing, and sufficient technical and

interdisciplinary expertise at the University of Bonn should be further elaborated in order to improve the feasibility of LARC.

## II.11 MD-MAXI

Magdeburg Center for (Bio-)Medical Advanced X-Ray Imaging (MD-MAXI)

Responsible institution: Otto von Guericke University Magdeburg (OVGU)

Installation costs: approx. 60 million euros

MD-MAXI aims to develop novel preclinical and clinical biomedical imaging techniques such as X-ray fluorescence imaging, dark-field imaging and other approaches using high brilliant X-rays. The project seeks to enable new medical applications like pharmacokinetics and personalised medicine. Beyond this, there are applications in theranostics, ultra-fast and ultra-high spatial resolution radio-therapy, as well as methods for characterising materials. It is intended to install two irradiation units with adjoining measurement laboratories equipped with positioning systems and detectors of various types for research and industrial utilisation. These will be supplemented by a biolaboratory, animal housing for temporary accommodation of test animals, and MRI for comparative characterisation and imaging. The planned location for construction and operation is Magdeburg.

### *Assessment*

Although the use of the aforementioned X-ray source for biomedical purposes is a novelty, the research objectives and intended contributions remain unclear in view of the **scientific potential** of MD-MAXI. Key aspects such as scientific goals and ambitions, plans for long-term research, a value for the brilliance of the X-ray source, or details on the application of the second radiation generation unit are not sufficiently explained. Given its specific focus and short operating time of 15 years, it is unclear how MD-MAXI will address emerging scientific topics and questions.

Given the limited access to synchrotrons, the project offers new and promising scenarios for **scientific utilisation**, particularly for biomedical research groups. The fact that MD-MAXI is designed as a platform for interdisciplinary collaboration and services as well as its commitment to providing analysed data sets can be of great value to its users. However, the potential use of the RI by external parties appears limited compared to synchrotrons, and commercial utilisation including resulting revenues are difficult to estimate.

In view of its relevance for **Germany as a location of science and research**, MD-MAXI's planned use of the aforementioned X-ray source for biomedical applications is unique worldwide, or at least rare. Due to the special technological application, the project has the potential to be of interest to the biomedical research community and to strengthen Germany's position in

international competition. However, the fact that the X-ray source is to be produced by a US company should be viewed critically in terms of the visibility of German research performance and, in particular, competitiveness.

For the assessment of the **feasibility from a scientific perspective**, the dependence on a single company for the manufacture of the X-ray prototype without convincing plans for risk mitigation is a key critical aspect of the “high-risk, high-gain” ratio. The complexity of X-ray technology and the need to develop additional equipment to utilise this technology pose additional challenges to the feasibility of MD-MAXI. Furthermore, the implementation of scientific milestones is not sufficiently explained.

II.12  $\mu$ e-Bauhaus Erlangen

Mikroelektronik-Bauhaus Erlangen ( $\mu$ e-Bauhaus Erlangen)

Responsible institution: Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU)

Installation costs: approx. 348 million euros

$\mu$ e-Bauhaus Erlangen envisages a research and innovation infrastructure that addresses the necessary reduction of energy consumption and the increase of its efficiency with a scientific focus on (ultra)wide bandgap ((U)WBG) semiconductors. The RI is intended to form an agile structure of research, industry participation, education and transfer by combining research and education of the FAU with the research and industrial collaborations of the neighbouring Fraunhofer Institute for Integrated Systems and Device Technology (IISB). The emphasis of this planned research centre is on (U)WBG semiconductors for sustainable mobility and energy, as well as power electronics applications. These applications are cryogenic power electronics for climate-neutral flying, radiation-hard, robust electronics for the aerospace industry, monolithically integrated quantum sensor chips and high-performance power supply for data centres.  $\mu$ e-Bauhaus Erlangen is designed both as a training hub and an open platform for microtechnology research in direct cooperation with industrial partners in form of Joint Labs. The proposed RI located at the FAU plans to upgrade the existing cleanroom laboratory to a total of 4,000 m<sup>2</sup> cleanroom space in a new technology building.

*Assessment*

$\mu$ e-Bauhaus Erlangen addresses a highly relevant and timely research topic by focusing on the development of new wide and (U)WBG semiconductors, which in itself is already associated with high **scientific potential**. The planned provision of an open and highly equipped laboratory as part of a “from lab to fab” concept to the scientific and industrial communities is valuable and could potentially spur innovation and new technological developments. However, the

scientific vision and the resulting objectives could have been presented more clearly in the proposal. Similarly, despite the very high potential of the various research areas addressed, the added value of the RI for an understanding of the relevant questions could be emphasised more clearly. An inclusion of the applications of power electronics as important pillar of semiconductor research would further enhance the scientific value.

As part of the **scientific utilisation**, the opportunity to have access to a clean room would be attractive to any researcher, student or trainee working on the development of new semiconductor devices. The access model including cost share and rental fees for industrial utilisation should be addressed more thoroughly. The RI appears to be focussed on the regional scientific community and it remains uncertain whether it would be able to attract students and researchers from all over Germany. The cooperation with other German institutions working in similar areas would be very beneficial. The concept of an open lab for research and innovation and a closed path for commercialisation is sufficiently laid out. However, specific engagement from companies for the commercialisation of products is lacking. International users beyond the EU as well as interaction and engagement with the global semiconductor and power electronics sector should be addressed more directly.

The **relevance for Germany as a location of science and research** is high due to the research topic itself and a certain engagement on a national as well as European level can be expected. In order to have an impact beyond this, the RI needs a strong global commitment to keep pace with the rapidly evolving technologies and developments in this field and to remain in dialogue. This especially relates to the competitiveness and economic efficiency. The proposal could have further contextualised its approach with existing German institutions in order to show where it complements or competes with them and where opportunities for collaboration lie.

The budget and the outline of the timeframe are appropriate for the scientific solutions and **feasibility from a scientific perspective** is given. Key technical aspects and components such as power electronics applications, packages and growth should be addressed more thoroughly in order to demonstrate expertise and knowledge in all relevant areas. More information on the construction and operation of the planned new clean rooms would equally help clarifying whether the right tools and concepts exist for the successful realisation of such complex facilities. The project's overall persuasiveness is weakened by the fact that central aspects and components of semiconductor research, development and utilisation were not mentioned in the proposal or were not presented in sufficient detail.

Research Center for Sustainable Production and Circular Economy (naProKi)

Responsible institution: Technische Universität Berlin (TU Berlin)

Installation costs: approx. 126 million euros

naProKi aims at reducing energy and materials consumption by developing resource-saving production processes and efficient recycling strategies in a holistic and agnostic approach. This approach is intended to incorporate social, economic, and ecological considerations. The RI is designed to facilitate the development of flexible and modular production systems according to R-strategies (reduction, reuse, recycling), with the goal of extending the life cycle of products. Thereby, companies shall be enabled to respond rapidly to new requirements and advances in the circular economy. naProKi is supposed to serve as a central platform for collaboration between science and industry, with a focus on production and disassembly in the automotive and mechanical engineering sectors. The technical infrastructure is divided into three research areas – a digital production centre, a circular economy centre and a material research centre – all housed in a new building to be constructed. It comprises specialised research, prototyping, and recycling facilities, which are connected by a digital platform and automation system. Digital technologies such as digital twins and big data analyses, human-centric digital assistance systems, and intelligent automation technologies are set to complement the adaptive and modular production systems.

#### *Assessment*

naProKi displays a strong conceptual approach for implementing a circular economy paradigm at the intersection between people, machines and processes. This approach indicates a solid **scientific potential** and is supported by extensive and wide-ranging research questions. Although the breadth of the research areas enables interdisciplinarity and opportunities for collaboration, the topics addressed are formulated too generically to make the unique scientific characteristics and strengths of the RI recognisable. The social involvement in the paradigm shift regarding a circular economy and the associated sociological issues are valuable approaches, but they require concrete elaboration. The scientific innovation and output of naProKi remain abstract, as the planned procedures for realising this vision and answering the research questions come short. It is questionable whether the format of an RI is suitable for the planned development of a joint platform.

By incorporating various research areas, the RI is able to promote transdisciplinary collaboration between industry, academia and society in the course of **scientific utilisation**. Activities such as educational programs and dialogue with societal actors are supposed to enable naProKi to engage with

communities beyond the usual user groups. This endeavour could be supported by further formats and efforts. The description of data access and utilisation is solid and provision of access for research purposes free of charge is commendable. However, the data management plan would profit from more details, including the open format storage of data, to emphasise naProKi's special utilisation value. Beyond the support of industry-related research towards a circular economy, naProKi's utilisation plans would also benefit from stronger consideration of further national research facilities and expertise, for example from the social sciences.

The field of sustainable production and circular economy addressed by naProKi is of high **relevance for Germany as a location of science and research** both at international and national level. The project's proposed research aligns with European and global sustainability goals. naProKi's partnerships and research fields, including areas such as battery life cycles and digitalised production processes, are suitable to enhance Germany's visibility and competitiveness significantly. The proposed collaboration between reputable partners from research, business and science is of high value and strategic importance. A stronger consideration of further partners and national research institutions pursuing similar endeavours, as well as the consideration of naProKi's position from a European perspective would enhance the proposal even further.

In terms of **feasibility from a scientific perspective**, the timeframe, requirements and risk assessment can be described as carefully documented and appropriate. The available structures, initiated measures and considerable commitment at the TU Berlin as well as the contributions of partners suggest sufficient institutional conditions and mostly successful planning of the RI. However, the draft proposal requires further technical details to enable an assessment of the project's feasibility beyond a general statement. This includes, for example, specifics concerning the number of used machines and digitalised production standards such as hosting, engagement of vendors and potential strategies for open-source services. Overall, naProKi's many valuable plans would profit from more in-depth explanations and detailed examples.

## II.14 NLP

National Laboratory for Photonic Science and Technology (NLP)

Responsible institutions: Fraunhofer Institute for Applied Optics and Precision Engineering (IOF) | Fraunhofer Institute for Telecommunications, Heinrich-Hertz-Institut (HHI) | Max Planck Institute for the Science of Light (MPL)

Installation costs: approx. 267 million euros

NLP plans to establish a distributed RI with the aim of advancing the development of key photonic technologies for the generation, transport and processing of optical information. The aim is to exploit advances in light

processing based on enhanced control and selective manipulation of light across all wavelength scales. Leveraging the expertise of its member institutions, NLP aims to promote and integrate four key pillars of photonic technologies for complete control of light: free-form optics and systems, fibre technologies, photonic integrated circuits and chip-based platforms, as well as nano-optics and metamaterials. Scientific and industrial applications include Earth observation, environmental monitoring, optical astronomy, optical communication networks, quantum systems and photonic computing.

#### *Assessment*

The comprehensive approach to promoting key photonic technologies promises significant advances and enormous **scientific potential** in space-based applications, high-performance systems and quantum communication. Particularly noteworthy are the novel design principles and special production techniques for free-form optics and nanostructures, which enable unprecedented control over light manipulation on various scales. The collaboration between different institutes with complementary expertise is a clear strength and has the potential to enable a more comprehensive approach to photonics research and broad coverage of the innovation chain.

With regard to **scientific utilisation**, the project offers attractive application possibilities ranging from sensor technology to quantum computing, which are equally interesting for users in science and industry. The strategy presented for interaction with various industrial partners is particularly convincing, especially in the field of quantum and optical components. The data and software management, which is based on FAIR principles, also stands out positively. However, it should be noted critically that there is no concrete strategy for involving the scientific community and that no idea of the actual utilisation of the RI could be conveyed. The extent of academic participation and the modalities of access for external users to the proposed facilities are less convincing and need to be further clarified. In particular, it is suggested that a central contact person should be designated for all enquiries and that access for external users be made clear and transparent. There is also room for improvement in terms of developing utilisation concepts and securing intellectual property, particularly with regard to industrial cooperation and open access ideas.

The project corresponds with Germany's strategic interest in technological leadership in areas critical to the future, particularly those that are crucial to economic competitiveness. Photonics, as a key technology for telecommunications, healthcare and high-tech production, requires both fundamental and applied research. In order to fully exploit the potential for strengthening **Germany as a location of science and research**, a further developed technology transfer strategy is recommended. The relevance for Germany and also Europe is confirmed by numerous letters of support, but it

must be critically noted that the claim to uniqueness should be questioned in view of similar initiatives such as PhotonHub at European level. Overall, NLP has the potential to function as a centre for photonics research in Europe and to promote scientific and industrial exchange locally, nationally and across Europe through international student programmes and other initiatives.

From a scientific perspective the **feasibility** is questionable, as the operational structure and specific integration remain unclear. The concept requires a more comprehensive risk analysis and a clearer division of tasks between the participating institutes, particularly with regard to the technologies to be used. The added value of the project's centralised approach could be elaborated in more concrete terms. A more specific selection and definition of measurable milestones as well as more detailed project planning are recommended. The draft proposal would further benefit from a more precise specification of the methodology and equipment necessary to achieve the stated objectives. The distribution of resources and administrative tasks is generally well planned, but the practical implementation should be further elaborated.

#### II.15 ORCHEStRa

Open Research Center for the Holistic Exploration of Safety and Efficiency in Real Traffic (ORCHEStRa)

Responsible institutions: Technische Hochschule Ingolstadt (THI) | Technical University of Munich (TUM)

Installation costs: approx. 124 million euros

ORCHEStRa aims to establish a modular hardware and software architecture as “software-defined traffic infrastructure” based on the growing performance of sensor, processor and communication technologies which enable high resolution recording and processing of traffic data. As an intelligent traffic infrastructure, it is intended to perform real-time monitoring and capturing across all relevant traffic spaces. This is expected to generate extensive datasets to investigate current research questions in the areas of traffic safety and intelligent, automated traffic, for example through a real-time digital performance twin and the development of novel algorithms. ORCHEStRa is planned as a distributed RI creating two large-scale intelligent and networked infrastructure areas in real traffic lined with intelligent Road Side Units (iRSU). At both sites in Ingolstadt and Munich, local test fields are supposed to be incorporated and the system architecture complemented by control centres for coordination and computing resources, drone ports and central data storage systems.

ORCHEStRa is an ambitious and comprehensive project that promises to deliver advances in the field of intelligent transportation systems. Its key **scientific potential** lies in its holistic, “software-defined infrastructure” that fuses real-time, high-resolution traffic data with advanced sensor networks and distributed computing. The aim of making these data publicly available is particularly promising, whereby the strict regulations of the EU and social acceptance must be addressed. The modular platform is intended to enable the testing of state-of-the-art algorithms as well as research on current and emerging questions. Through its integrated platform, the RI has a high potential for interdisciplinarity involving different fields such as AI, robotics, or IoT. ORCHEStRa’s own scientific research objectives and their realisation as well as the use of AI could have been presented more concretely and vividly in the draft proposal. It would also be essential to contextualise the RI more strongly in the European and, in particular, the global context in order to highlight the uniqueness of ORCHEStRa. As a consequence, the strengths of a science-orientated RI remain too abstract compared to test fields in China and the USA.

An RI in the field of intelligent traffic infrastructure is essential for enabling advanced research in the fields of transportation, sensor technologies and algorithm analyses. Regarding the **scientific utilisation**, ORCHEStRa is open and attractive to a large and diverse user community from scientific or public institutions as well as industry and social organisations. Especially laudable is the practical and scalable tiered access model that gives prioritised access to academia and fee-based access to industry. However, there are minor doubts how the scientific communities outside of the responsible institutions as well as users from politics and society will be addressed, activated and supported. Furthermore, the RI would benefit from connecting with other German universities and research institutions as well as from a more global outreach. Access to and opportunities to process a dataset of the envisaged scope and significance is highly valuable and unique for scientific as well as industrial users.

ORCHEStRa promises clear benefits for traffic safety and efficiency, which is of great **relevance for Germany as a location of science and research**. It has the potential to reinforce Germany’s leadership position in intelligent transportation systems. The test platform’s modularity and the holistic methodological approach make ORCHEStRa competitive and attractive, despite the existence of analogous facilities in a global context. The RI further distinguishes itself through its commitment to open data, open access, strict data privacy standards, ethical AI, and the integration of drones. The RI is well connected to parts of the private sector which is important given its essential relevance for delivering commercial technologies. However, it appears to be less

well networked with the automotive industry and other German research institutes.

The responsible institutions THI and TUM have solid experience in creating and maintaining such an RI. They provide the best institutional conditions for successful implementation and **feasibility from a scientific perspective**. The planning is outstanding and the technical solutions are highly feasible. However, the technical part of the project requires a careful and comprehensive risk management, particularly regarding risks around technological advancements, cybersecurity, interoperability, and energy supply. The risk management plan shows a clear awareness of these risks. For example, the phased upgrade approach allows the RI to keep pace with technological advances ensuring its continued functionality. Risk mitigation measures for safety-critical elements of AI, or challenges in the technical implementation by a subcontractor should, however, be given greater consideration in the draft proposal.

## II.16 OSIRIS

### Open Science Information and Research Infrastructure (OSIRIS)

Responsible institutions: Leibniz-Institut zur Analyse des Biodiversitätswandels (LIB) | Deutsches Museum (DM) | Leibniz Institute DSMZ – German Collection of Microorganisms and Cell Cultures | Leibniz Institute for Information Infrastructure (FIZ) | Leibniz Institute for Plant Genetics and Crop Plant Research (IPK) | Leibniz Institute for Zoo and Wildlife Research (IZW) | Leibniz-Zentrum für Archäologie (LEIZA) | Deutsches Bergbau-Museum Bochum (DBM) | German Maritime Museum (DSM) | Museum für Naturkunde (MfN) | Senckenberg Gesellschaft für Naturforschung (SGN) | Staatliche Museen zu Berlin – Stiftung Preußischer Kulturbesitz (SMB-SPK) | Botanischer Garten und Botanisches Museum Berlin, Freie Universität Berlin (BGBM) | Bavarian Natural History Collections (SNSB) | State Museum of Natural History Karlsruhe (SMNK) | Stuttgart State Museum of Natural History (SMNS) | Germanisches Nationalmuseum – Leibniz-Forschungsmuseum für Kulturgeschichte (GNM)

Installation costs: approx. 472 million euros

OSIRIS aims to create and maintain a comprehensive national infrastructure for cultural, technical, and natural history collections (including living collections and gene banks) in Germany. It is intended to contribute to an understanding of human-environment relationships, along with their sustainable management by enabling interdisciplinary analyses and modelling of human-environment relationships within a socio-ecological framework. OSIRIS plans to digitise and integrate essential collections in Germany into a decentralized, open information and knowledge infrastructure with over 160 million objects. It is supposed to comprise a publicly accessible data platform, a virtual research

environment, as well as thematically structured interdisciplinary and transdisciplinary labs, the i-labs and t-labs.

#### *Assessment*

The **scientific potential** of OSIRIS lies in the plans to address relevant research questions on human-environment interactions and the sustainable use of natural resources. The most important planned innovation is the integration of data on natural objects and cultural assets in a common digital platform. The contribution that OSIRIS intends to make to the interdisciplinary cooperation required for this should also be emphasised. To this end, the project plans to promote cross-collection methodology development and collaboration. In addition, OSIRIS wants to offer transdisciplinary application possibilities, such as the rapid identification of organic materials, which could also be of use to authorities and various branches of industry. However, these aspects should be worked out in more detail. Overall, more clarity would be desirable with regard to the overarching vision and the social added value of the project.

For **scientific utilisation**, the openness of the platform and compliance with CARE (Collective Benefit, Authority to Control, Responsibility, Ethics) and FAIR principles are defining features of OSIRIS. Due to the attractiveness of the RI for researchers from the natural sciences to the humanities, a large user community from Germany can be expected. In particular, the functions provided, such as “Digitisation on Demand”, are characterised by their user-friendliness. However, the international appeal is not addressed in the draft proposal and is not self-explanatory. In addition to scientific communities, OSIRIS also addresses a non-scientific user community by setting up i-labs and t-labs for inter- and transdisciplinary research. These labs promise an innovative approach, but their functioning and role in knowledge transfer could be described more clearly in the draft proposal. In particular, it could be explained more specifically how the t-labs are intended to promote knowledge transfer – arguably a core mission of the OSIRIS members – and overcome known challenges of applying citizen science to knowledge transfer.

OSIRIS is of high **relevance for Germany as a location of science and research**, as it offers access to its natural and cultural heritage via an interdisciplinary, cross-collection digital platform. The project is supported by a consortium of partner institutions that preserve Germany’s immense scientific and cultural heritage, which is of great value for research. In addition, the consortium’s expertise and international network ensure integration and collaboration at national and global level. OSIRIS has the potential to become a major knowledge infrastructure providing evidence-based support for decision-making and policy-making. However, the global attractiveness and relevance of German cultural heritage could be more clearly emphasised.

The necessary technology and expertise are available for a mass digitisation scheme such as OSIRIS is planning. In terms of **feasibility from a scientific perspective**, however, the description of the technical characteristics of the RI could be even clearer – especially with regard to data generation, the integration of AI and interoperability. In addition, it could be explained in more detail how the central challenge of integrating different data from different sources is to be solved. The reasons for choosing a decentralised repository instead of a more efficient distributed solution and the continued operation of the RI should be explained and described more clearly.

#### II.17 PrecFer4innoP

##### Precision Fermentation for innovative Products (PrecFer4innoP)

Responsible institutions: Leibniz Institute for Agricultural Engineering and Bioeconomy (ATB) | University of Osnabrück (UOS)

Installation costs: approx. 79 million euros

PrecFer4innoP aims to drive innovation in sustainable bioeconomy by developing and implementing a precision fermentation strategy as well as smart biorefinery systems. The planned smart and modular biorefinery is based on precision fermentation and integrates advanced digital technologies such as AI, data-driven decision making and automation. Thus, it is intended to optimise processes in biomass conversion for maximum efficiency and sustainability, aiming for a substantial contribution to a robust circular bioeconomy. A core element of PrecFer4innoP is the development of biorefinery pilot and demonstration plants utilising precision fermentation to transform biomass and/or agricultural and organic waste into innovative products like healthy foods, biochemicals, biofuels and bioplastics, while supporting climate mitigation efforts. The RI is intended to test and demonstrate feasibility at both bench and pilot scales. It thus aims to lay essential groundwork for the future development of fully automated industrial-scale biorefineries that can integrate single or multi-system configurations.

##### *Assessment*

Regarding the **scientific potential**, the idea of a modular biorefinery system that flexibly adapts to different materials, processes and products is valuable. It is supposed to give users the opportunity to explore their own calibrations and combinations of sequences and components according to their specific needs. However, the individual technical components and modules as well as the development of new control systems can be described as established standards and lack potential for innovation. The creation of a digital twin and the exploitation of AI have the potential to lead to further insight and technological improvements while helping to answer newly emerging questions, but the draft proposal should provide more details and vision regarding the RI's digital

concept. The RI would further benefit from clearer explanations on its key biotechnological concepts such as precision fermentation and processes such as pyrolysis.

According to the concept for **scientific utilisation**, the RI's pilot plant offers scale-up services to research institutions and industry, which address the gap between lab and pilot scale and eventually commercial scale. However, a more detailed access model as well as a precise and quantifiable picture of the targeted users would be necessary to assess PrecFer4innoP either as a regional hub for the agricultural community or as a research centre with nationwide appeal. The proposal would thus benefit from a diverse stakeholder portfolio including committed local farmers and suppliers, agricultural associations and different companies from agriculture, food or other bioeconomical sectors.

Research towards a sustainable bioeconomy as well as facilities and institutions supporting this goal are of high **relevance for Germany as a location of science and research**. There are several pilot facilities in Germany and Europe that work in similar areas and provide comparable services, though. The draft proposal does not convincingly demonstrate its unique features and how it differs from these competing facilities. Thus, an increase of attractiveness, visibility or competitiveness of Germany as a research location cannot be expected. While local companies might benefit from this RI and its provided services, which can have a positive influence on the agricultural sectors in Brandenburg and Lower Saxony, it remains questionable whether this impact could be expanded to a nationwide level or even beyond.

Contrary to the originally submitted list of responsible institutions, the German Institute of Food Technologies (DIL) no longer acts as a responsible institution, but only as a partner. It remains unclear, what impact this has on the RI's goals and intentions as well as their **feasibility from a scientific perspective**. Overall, the technological components, the integration of a modular system as well as the utilisation of ML are well-established in the field and their implementation is of low risk. However, the lack of detailed elaborations in the draft proposal concerning materials supply, digital twin and AI applications as well as precision fermentation and other processes impedes the assessment of feasibility from a scientific perspective.

## II.18 Q-MUC

Quantum Munich Labs (Q-MUC)

Responsible institution: Bavarian Academy of Sciences and Humanities (BAW)

Installation costs: approx. 317 million euros

Q-MUC aims to establish a national deep tech innovation centre dedicated to the research and development of novel solid-state-based quantum devices, alongside

the hardware-specific software required for their design and operation. The centre is intended to provide the infrastructure and technical expertise for the production and characterisation of quantum sensors and processors, discrete quantum components and networks. By focusing on physical concepts and advancements in the realisation of fault-tolerant quantum technologies, Q-MUC seeks to drive the transfer of quantum technologies into the economy and foster their application in industry. With facilities for the automated high-throughput characterisation of nano-photonic circuits and spin-based quantum emitters, as well as for in-situ nanofabrication for location-selective control, the centre is designed to support the development of high-quality quantum systems and circuits. As a national RI, it aims to promote innovation by linking academic research with industrial applications of quantum technologies.

#### *Assessment*

In terms of **scientific potential**, Q-MUC presents itself as an extremely ambitious and innovative RI with the potential to drive scientific and technological progress in the field of quantum technologies. The project is interdisciplinary in nature and offers the opportunity to bundle R&D in the areas of quantum materials, software and clean room services within an integrated structure. The orientation towards leading international institutions underlines the strategic self-image of the project and suggests that it aims to position itself as a relevant player in Germany's growing quantum environment. However, there are conceptual weaknesses that could currently limit the success of the project. A more precise definition of long-term goals and targeted research fields, a systematic assessment of potential risks, especially when handling helium-3, and a clearer design of the planned contamination management and operational efficiency would significantly strengthen the reliability of the infrastructure's operability and sustainability concept.

The project's concept for **scientific utilisation**, combined with its interdisciplinary nature, promises broad adoption in both academia and industry, creating valuable opportunities for internal and external users. The open utilisation concept for clean rooms described in the draft proposal could open prospects for increased cooperation between the quantum community and industrial players and create synergies for the development and application of quantum technology innovations. A more precise definition of the access modalities and necessary training could further strengthen the expected impact of the RI on the research community. To realise the full potential of Q-MUC, it would be beneficial to elaborate on the utilisation concept in important areas such as access, contamination management and operational efficiency. The targeted consideration of these key factors would be essential to highlight Q-MUC's potential for innovation and the contribution to quantum technology research that the RI intends to make in this promising field.

The project is of high **relevance** and offers a strategically important opportunity to significantly strengthen Germany's position in global quantum research and increase its attractiveness and visibility as a **location of science and research**. By providing state-of-the-art clean room facilities and shared resources for research, development and prototype production, Q-MUC could sustainably promote collaboration between academia and industry. The user-centred approach and advanced cleanroom equipment could help the facility to play a key role in international quantum research, promote innovation in the field of quantum-based materials and technologies, and thus provide new impetus for science and industry. Despite existing financial risks, particularly due to the dynamic and rapidly evolving quantum landscape, the investment in this innovative infrastructure offers promising prospects for the advancement of quantum technologies in Germany.

In terms of **feasibility from a scientific perspective**, the draft proposal demonstrates promising approaches. The project benefits from the comprehensive expertise of the responsible institution and partner institutions. However, closer integration with existing national initiatives and strategically secured adaptability to dynamic developments in the field of quantum technologies would be advisable. The concept offers a solid risk strategy, but potential challenges can still be identified, particularly regarding implementation and the associated risks. The long installation phase of ten years carries the risk that the RI may not be completed in time to keep pace with the rapid developments in quantum research and meet its requirements. A more detailed project description, for example with regard to the need for a new building or a planned training programme, would be desirable to provide additional clarity regarding the establishment of the RI. A more precise description of the governance structure and more comprehensive explanations of risk management and planned services could further increase the development potential of the RI and improve its chances of success.

## II.19 SKAO

Square Kilometre Array Observatory (SKAO)

Responsible institutions: Dresden University of Technology (TUD) | Max Planck Institute for Radio Astronomy (MPIfR)

Installation costs: approx. 148 million euros

SKAO is a global, intergovernmental project with radio astronomical and computing facilities in Africa, Australia and Europe. With two synergistic radio telescopes operating at low and mid radio frequencies, SKA-LOW and SKA-MID, the SKAO will provide new research capabilities to the global astronomy community. In order to strengthen Germany's position within the SKAO and enable the German scientific community to play a more prominent role in key

research initiatives, the project aims to enhance the SKA facilities. These enhancements are to provide new scientific capabilities, thereby advancing the overall research potential of the RI. The upgraded SKAO is expected to contribute to understanding key aspects of the universe, including its origin, constituents, and fundamental interactions, while supporting advancements in natural sciences and engineering.

#### *Assessment*

The SKAO has great **scientific potential** and enables major advances in astrophysics. The proposed technological improvements are expected to significantly advance research in pulsar timing, cosmic ray tracking, and high-resolution imaging. In addition, the project is expected to establish new standards in the management of exabyte-sized data sets – with far-reaching applications beyond astrophysics. A fundamental uncertainty exists regarding the specific scientific impact of the proposed enhancements. It remains unclear what added value the proposed German contribution will bring to the overall project, so further clarification is required in this regard.

It is generally expected that the proposed contribution will further expand the German (radio) astronomy community and help to further extend the **scientific utilisation** of the SKAO. The project addresses a wide range of users from various fields, such as astrophysics, physics, data science and engineering, who will benefit from the improved data management capabilities. Overall, it offers promising access opportunities, high usability standards and significant benefits for the entire scientific community in the field.

**Germany as location of science and research** has already played a crucial role in the development of the SKAO as an overall project and has made considerable scientific contributions that underscore its leading position in the field. The proposed enhancements will further sharpen the SKAO's profile and are in line with national scientific priorities. Germany's more intensive participation in the SKAO offers the opportunity to significantly increase German impact in various fields of astronomical research. Due to its long-established expertise in radio astronomy, Germany is well positioned as a key player in the global community. The integration of the German SKA Regional Centre (DSRC) will further strengthen the connection to SKAO, providing a great opportunity to promote efforts in the areas of data management, algorithm development and data reduction. The proposed contributions will further strengthen Germany's role as an important player in the international community in this field and consolidate its leading position in radio astronomy.

The extensive expertise of the German community in the field of radio astronomy provides the responsible institutions with an excellent basis for implementing the proposed enhancements and promises seamless integration into the national framework for astronomical and astrophysical research. In

addition to the excellent institutional conditions, close cooperation within German radio astronomy and previous project successes also indicate a high degree of **feasibility from a scientific perspective** for the project. The physical infrastructures and data components are based on established systems, which minimises risks and makes successful implementation highly probable.

## II.20 SuperCoHD

### High-Performance Computing Infrastructure for Health Data (SuperCoHD)

Responsible institutions: Berlin Institute of Health at Charité (BIH) | CISPA Helmholtz Center for Information Security (CISPA) | German Cancer Research Center (DKFZ) | Helmholtz Munich – Environmental Health Center (HMGU) | Max Delbrück Center for Molecular Medicine in the Helmholtz Association (MDC)

Installation costs: approx. 466 million euros

SuperCoHD aims to create a national, high-performance computing infrastructure for health research in an integrated data space. The goal is to address the challenges of data usage and the development of data-based solutions and AI models in health research. This is supposed to help identify risk factors and the prerequisites for individualised risk prediction as well as contribute to the development of innovative diagnostic and therapeutic solutions. The high-performance computing power can be available both in a dedicated data centre and in a cloud solution, and data storage can be both federated and centralised. Both would follow a hybrid approach.

#### *Assessment*

SuperCoHD is an extremely ambitious project with highly relevant methodological and application-orientated research goals. The plan is to create a future-proof, multi-purpose infrastructure for data-driven and data-informed research that has the **scientific potential** to enable essential advances in health research. This RI intends to provide the necessary conditions for gathering, storing, managing, and processing large volumes of highly sensitive health and clinical data in compliance with the stringent EU regulations. SuperCoHD is expected to deliver significant outputs and offer tangible benefits to researchers, healthcare professionals, policy-makers, and patients. The RI is highly relevant to advance health research as well as data management and digitisation in clinical applications.

In terms of **scientific utilisation**, SuperCoHD aims to provide a central and single access point for health data that will serve all stakeholders in health research. The project is thus responding to a major need in health research and is aimed at a large user community by offering data access and computing capacities as well as applications for the general public, such as a platform for

patients. However, the use of the RI by these target groups will most likely be a gradual process that requires trust-building and a solid communication strategy. Issues of interoperability of the diverse health data, GDPR compliance (General Data Protection Regulation) and user reservations regarding the sharing of sensitive data should be addressed more clearly.

A digital RI for health research is urgently needed and would be of high **relevance for Germany as a location of science and research**. Against this background, SuperCoHD promises to support the development and evaluation of new health technologies. The project is expected to put Germany at the forefront of research and innovation in the healthcare sector and make it an attractive location for high-quality clinical research. SuperCoHD offers significant benefits for healthcare and public health and can help to bring Germany to the forefront in an area that has so far been rather reluctant to embrace digitalisation. The responsible consortium is very well positioned to promote integration into and cooperation with newly emerging European initiatives. Researchers in the EU, where the collection and processing of personal data, especially health data, is highly regulated, will likely benefit from this RI.

In terms of **feasibility from a scientific perspective**, SuperCoHD is understandably planning a phased development with a flexible and modular approach in order to be able to respond to changing demands and technologies. The project's basic contributions to health data management are feasible as they build on available technologies and expertise and should be realisable in a shorter installation phase. However, achieving the more ambitious goals of the RI depends on successfully solving two challenging IT problems for which there are no promising research approaches in the short to medium term: firstly, confidential, scalable and resource-efficient data processing and secondly, scalable, evidence-based and trustworthy AI solutions. With regard to the IT components, the draft proposal lacks technical correctness and attention to detail. The development and use of expertise in the field of computer science is of crucial importance in order to effectively manage the risk of excessive dependence on industry knowledge and solutions from the USA and thus avoid a single point of failure. This is highly relevant with regard to Germany's digital sovereignty and compliance with the applicable data protection regulations. Another risk is the widespread reluctance in the discipline to share data. However, the responsible institutions are in a good position to drive forward the necessary change in this regard.

Toward a terrestrial digital twin of Germany for sustainable use and management of the land surface (TerraNet)

Responsible institution: Forschungszentrum Jülich (FZJ)

Installation costs: approx. 115 million euros

With TerraNet, a terrestrial digital twin of Germany is supposed to be established, that provides precise knowledge of the state of German ecosystems and enable forecasts of their evolution at a daily to seasonal scale. This digital twin is intended to consist of (near-)real-time, fully digital, connected, standardised, and harmonised observations from the groundwater to the atmosphere. The intention is to collect observations in a digitised, nationwide observational platform that builds on existing environmental monitoring networks. Observation data shall be further processed to high-level information products in a high-performance cyberinfrastructure. The RI's research objectives cover methodological challenges such as the efficient regionalisation of spatially discontinuous information, the development of new sensors or the effect of climate extremes on different ecosystems. Target user groups are research institutions, other RIs, governmental and environmental agencies, policy-makers, NGOs, environmental consultancies, local communities as well as education institutions. TerraNet is supported by a total of 50 universities, non-university research institutions and public authorities.

#### *Assessment*

TerraNet is an ambitious project that has the **scientific potential** to accelerate the acquisition of research knowledge on complex earth science problems through access to high-quality and trustworthy data and data analysis tools. The endeavour to build a terrestrial digital twin of Germany based on (near-)real-time data is of considerable scientific relevance in the context of climate change. The multi-dimensional approach of TerraNet, which is based on high data storage and computing capacity, promises an adequate framework for research into complex weather events. The project has the potential to promote inter- and transdisciplinary collaboration between a variety of disciplines such as agriculture, forestry, earth and atmospheric sciences or biology. It will potentially be an important instrument for a large scientific research community as well as for stakeholders from the fields of agriculture, forestry, freshwater and coastal ecosystems.

In terms of **scientific utilisation**, there is great demand from various research communities, environmental agencies, policy-makers and other stakeholders, especially for the data and data products that TerraNet aims to provide. The RI promises open access and adherence to FAIR principles in data management, but the draft proposal has several limitations in this respect: The description of data

management and data architecture do not meet the necessary technical standards. Data integration is not sufficiently elaborated on, although it is of utmost importance in a project that brings together such a large number of institutions from different fields using different data and data standards. The publication of data under the Creative Commons CC-BY-ND licence is a serious restriction on data usage, as it does not allow data to be combined or modified, e.g. for the creation of new indices and models. This should be taken into account in the further development of the project.

In terms of its **relevance for Germany as a location of science and research**, TerraNet has the potential to be one of the world's leading infrastructures in the field of earth sciences. In international comparison, there are similar RIs in Australia, China and the USA, which relate to the respective national context. TerraNet plans to provide comparable data for Germany and thus complement global environmental observation and research. A key unique selling point of TerraNet is the planned development of a digital twin with a forecasting function. TerraNet is involved in European initiatives such as eLTER-RI, even though the draft proposal contains little information about the cooperation and synergy potential. Similar RIs exist in Germany, but TerraNet differs significantly from them in terms of its geographical and thematic breadth. It is therefore expected that TerraNet can have a significant impact in Germany, Europe and even on a global level. Even a partial realisation of the project would already form a basis for significant scientific progress in experimental terrestrial research. Provided that data integration is achieved, the RI can improve the monitoring of ecosystems and biomes. The project is supported by a large number of relevant and important national partner institutions that have already done extensive preparatory work.

With regard to **feasibility from a scientific perspective**, it should be noted that the project is supported by a consortium consisting of all relevant stakeholders who contribute their respective expertise. However, the goal of creating a terrestrial digital twin within the set timeframe is too optimistic. It does not take sufficient account of the challenges in terms of data availability and the integration of heterogeneous data. The RI could only take a first, albeit important, step towards the future realisation of a digital twin, but could not realise the promised added value through forecasting functions. In view of the major challenges and the inadequate and unclear description of the central data architecture from a technical perspective, the achievement of data integration and the associated potential for research are also not clearly evident.

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# C. Outlook and recommendations

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## C.1 INDIVIDUAL EVALUATION OF THE PROJECTS ON THE SHORTLIST

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At the request of the Federal Ministry of Research, Technology and Space (BMFTR), the mandated committee of the German Science and Humanities Council (WR) will conduct an individual evaluation of the projects included on the shortlist. The aim is to make recommendations on the implementation of the projects to the responsible institutions and the BMFTR. This individual evaluation is not competitive in nature, but primarily formative, meaning it assesses and evaluates the further plans for installing and operating the research infrastructure and the measures envisaged to achieve the project's objectives. In doing so, it takes into account the results and recommendations of the three assessment strands of the draft proposal phase and incorporates their refined evaluation dimensions into the assessment. A central function of the evaluation is the identification of scientific, technological and organisational milestones. This includes critical paths and termination points, for example in the form of single points of failure, which can lead to the discontinuation of federal funding for the project. For the evaluation of the plans for implementing a project with regard to the realisation of its scientific potential, cost planning, risk management as well as innovation and transfer measures, dimensions are applied that are based on those of the draft proposal phase. |<sup>29</sup>

The committee establishes working groups for the individual evaluation of the projects, consisting of members of the committee and external experts, with one representative each from the federal government and the federal states participating as guests. The working groups adopt an evaluation report on the respective project, which evaluates the project plans and contains recommendations for implementation.

In addition to the draft proposals submitted, the evaluation report is based on comments from the responsible institutions on the results of the science-driven

|<sup>29</sup> Federal Ministry of Education and Research (2024): Guidelines for preparing the draft proposal for a large research infrastructure, Bonn, p. 8 f. URL: [https://www.bmftr.bund.de/SharedDocs/Downloads/DE/-/2024/fis\\_priorisierung\\_unterlagen.zip?](https://www.bmftr.bund.de/SharedDocs/Downloads/DE/-/2024/fis_priorisierung_unterlagen.zip?)

assessment, the costs and risks assessment, and the assessment of the potential for innovation and transfer, as well as additional documents requested. Further, a site visit by the working group, usually at the lead responsible institution, is part of the evaluation process.

The committee acknowledges the working groups' evaluation reports and drafts a research policy statement containing recommendations to the responsible institutions and the BMFTR. In particularly justified cases, the committee may recommend to not fund a project. The evaluation reports will be published together with the research policy statement.

## C.II REFLECTION ON THE PROCESS AND RECOMMENDATIONS

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In the spirit of a learning process, key aspects of the design and implementation of the national prioritisation process are reflected on below. For the further development of the process, findings are documented and recommendations are made for its future organisation, in particular with regard to the proposition of a regular call for draft proposals.

### *Establishment of a permanent prioritisation process*

Research infrastructures of national significance are characterised by open utilisation, high potential for international, interdisciplinary and transdisciplinary cooperation, efficient RDM and adaptability to changing or newly emerging research demands. They thus provide significant added value for scientific communities, act as hubs for scientific and technical expertise, and help to reduce fragmentation and unnecessary redundancies in scientific services and resources. As the largest research location in Europe and in view of the need to maintain the international competitiveness of the German science system, Germany needs a strategic and long-term prioritisation of nationally significant research infrastructures.

Against this background, the committee considers it **urgently necessary to continue the science-driven prioritisation process for large research infrastructures on a regular basis**. The committee therefore welcomes the intention to continue the process expressed by the BMFTR when launching the call for draft proposals and publishing its shortlist. With the aim to serve as a strategic roadmap, a permanent prioritisation process should include not only a regular competitive selection process but also a long-term substantive analysis of research infrastructures as an area of scientific performance in a national and international context.

The number of submitted draft proposals, the types of institutions submitting, and the disciplinary diversity of the projects suggest a high potential for significant research infrastructures within the system of research and higher

education. In the committee's opinion, the increase of 35 projects submitted in the current prioritisation process compared to twelve projects in the last roadmap process cannot be explained solely by a longer period without a corresponding call for proposals. It rather shows the interest and willingness of scientific institutions to establish large research infrastructures that are openly available to research communities and serve to answer key scientific questions. In this respect, it can be assumed that participation in future selection and funding processes will continue to be high.

Due to the considerable resource requirements, the high technological and organisational complexity, and the importance of research infrastructures for scientific performance, it is essential to systematically prepare decisions on their prioritisation and funding. As these decisions for large research infrastructures create long-term path dependencies, a **competitive, science-driven assessment process** will continue to be necessary in the future. This process must be open to the entire scientific community and contribute to optimising the use of scientific resources and avoiding misguided investments.

Regardless of their scientific focus and structural design, research infrastructures must be understood and evaluated as socio-technical systems. Their performance is based on the combination of technical elements such as laboratories, large-scale equipment, instruments or digital resources, and social factors such as the scientists operating the infrastructure, technical and administrative staff, and, in particular, the users. When evaluating concepts for research infrastructures, both aspects must therefore be taken into account and this should continue to be reflected in the evaluation dimensions and processes.

While this selection process must remain open to the entire scientific community, it is also important to fully take account of developments and trends in the field of research infrastructures and to identify and **set strategically necessary priorities**. Some research areas depend on the establishment and use of large-scale equipment and facilities simply because of the nature of their research and therefore have a longer tradition of conception and fundraising for research infrastructures. In other research communities shared facilities and resources only became necessary or desirable in recent years. Further strategic development of the prioritisation process can take greater account of different disciplinary traditions and structures through appropriate measures. The committee can play a permanent role in this regard – for example, in identifying gaps in the landscape of research infrastructures for certain scientific fields and in facilitating exchange in areas where this format is less established or where it is considered particularly necessary. In addition, forward-looking prioritisation would make it possible to identify scientifically and socially relevant topics at an early stage and address them by means of research infrastructures. Key topics and priorities should be defined in a dialogue between science, politics, industry and society, and, if necessary,

supported by accompanying research. The prioritisation process can thus serve as a strategic instrument for identifying and pursuing these topics. Contextualisation in European and other international developments should play a prominent role in this context.

The intervals of the prioritisation process should correspond with the conception and planning period of suitable projects and enable timely consideration of technical, technological or methodological developments in scientific fields. From the committee's point of view, a four-year interval is appropriate for this purpose. The reliability of a regular call for proposals can help to reduce the number of submitted projects, that are in a very early stage of planning, and keep the overall number of projects within the process at a stable level. This would also allow to link the publications of the shortlist to legislative periods, thereby taking into account the fact that investment in large research infrastructures also involves science policy and fiscal decisions.

*Maintaining the structural and disciplinary openness of the process*

In future, the prioritisation process should continue to **ensure openness to projects from all scientific fields**. In the process carried out, the range of projects submitted was broad in several respects: In terms of the different types of infrastructure, it ranged from primarily technical facilities and large-scale equipment to digital infrastructures. Projects with a specific focus were represented, as were the development of subject-specific resources and service facilities or multidisciplinary user facilities. Plans were submitted for the establishment or upgrade of national facilities, for the development of German locations and hubs for European consortia, and for Germany's participation in international projects.

The participation of different types of scientific institutions in the process indicates that nationally significant infrastructure projects are being planned by both universities and non-university research institutions – in many cases in cooperation with each other (Figure 4). At around 60 %, non-university research institutions are the most frequently represented as responsible institutions. However, with around 30 %, a significant proportion of universities and university hospitals can also be observed. This is an increase compared to the previous roadmap process, in which universities and university hospitals accounted for approximately 25 % of the responsible institutions. Universities and university hospitals serve as responsible institution for three of the nine projects included on the shortlist.

With regard to disciplines from which the submitted draft proposals originate, the majority (21) come from the natural sciences and engineering. This is not surprising, as parts of these scientific fields pursue research questions that can only be answered through the use of large facilities and equipment. Large research infrastructures are therefore important for these disciplines, and they

are familiar with their design, construction and operation. Specific prioritisation and roadmap processes are rather common within these disciplines as well. The eight projects from the life sciences, including medicine, also account for a significant proportion of the draft proposals submitted.

The social sciences and humanities (SSH) are represented to a small extent in the process with two draft proposals submitted. RIDLOP is the first project from this field to be successful in the national prioritisation or roadmap process. Although further declarations of interest were submitted from the SSH and several projects focusing on other scientific areas aim to address or integrate certain disciplines of the SSH, participation in the process by these scientific fields remain low. This is despite a lower financial threshold for projects from the SSH and the inclusion of funding requirements for the initial acquisition and development of data, information and collections as part of the installation costs.

It is striking that of eleven declarations of interest for projects from the agricultural, food and nutritional sciences as well as environmental and earth system sciences, only three were developed into a draft proposal. In its position paper from 2024 called “Future perspectives for agricultural, food and nutritional sciences”, the WR recommended documenting, systematically opening up and strategically developing the rich and diverse stock of research infrastructures in these fields.<sup>30</sup> The committee reaffirms this recommendation. Based on initial feedback from these disciplines, the committee further assumes that due to the short submission deadline only a few draft proposals could be finalised in time.

Against this background, the committee encourages an exchange with stakeholders from the mentioned disciplines and scientific fields in order to develop suitable measures that promote their participation in the process.

#### *Retain the draft proposal phase*

**The format of draft proposal should be retained.** In contrast to previous roadmap processes, the assessment of projects in the prioritisation process was not based on full proposals submitted, but on draft proposals. This was done with the intention to make the process more open, especially for projects that are still at an early stage of planning. The same applied to the requirement that projects had to be ready for implementation within four years, meaning by this time the necessary R&D as well as organisational planning should be completed. Overall, the projects submitted therefore vary in terms of their planning and implementation maturity, ranging from projects that are still in the early stages of idea and concept development to those that have been in development for

<sup>30</sup> German Science and Humanities Council (2024): Future perspectives for agricultural, food and nutritional sciences; Cologne, p. 28-31. DOI: <https://doi.org/10.57674/a4rt-ke57>

many years possibly including pre-financing and that already have conceptual design reports (CDRs) or TDRs as well as mature utilisation concepts. A high proportion (approx. 44 %) of the projects submitted had already undergone internal prioritisation processes, which were published, for example, by the Helmholtz Association or the Leibniz Association, or within individual scientific communities, e.g. as roadmaps. In contrast, for around 56 % of the projects, there is no information available as to whether they were previously prioritised or evaluated. Two-thirds of the projects that have been included on the shortlist can be assigned to the group of projects prioritised in advance. One might conclude that projects that have already been planned in detail and prioritised by scientific organisations or disciplinary communities have a higher chance of being included on the shortlist, but this should explicitly not be understood as an indirect selection criterion. Rather, openness to less developed and pre-tested concepts should be maintained. This would continue to enable actors without the necessary resources to participate in the process and allow for flexible and timely consideration of research topics and novel research infrastructures.

Despite this openness to projects in an early planning phase, however, draft proposals should contain convincing presentations of the scientific potential and the technological, organisational and financial feasibility. The format of a draft proposal must also address the scientific questions and objectives in relation to the requirements and competencies of a research infrastructure. It must contain comprehensive concepts with a sufficient level of detail, covering aspects ranging from utilisation and digitisation to practical operational procedures. If institutions are uncertain whether a planned project is generally suitable for submission, they should in future have the option of **submitting a preliminary draft** before preparing a full draft proposal. Such a preliminary draft can serve as an initial presentation of a planned project prior to detailed review and assessment and can be discussed in a consultation meeting. This would give applicants quick feedback on an initial concept – both in terms of the project's basic suitability for the process and in terms of its elaboration with regard to the assessment dimensions. For the committee, preliminary drafts would provide helpful indications of potential in the research system and the possibility of connecting related projects. The submission of a preliminary draft would be optional: projects that are already at an advanced stage of conception and implementation, for example due to prioritisation, inclusion on a roadmap or other relevant preparatory work, could still directly submit a full draft proposal. Therefore, the committee recommends a **longer duration for the call for draft proposals** compared to the current procedure.

There was no direct exchange between the working groups or the committee and the institutions responsible for the projects during the review and assessment process. Although the working groups were in principle able to formulate questions to the responsible institutions on the basis of their review, this option was not used because the schedule did not allow for responses to be

received during the working groups' review process. For the working groups and the committee, this meant that the draft proposals submitted had to be reviewed and assessed solely on the basis of the information contained therein. In future, the procedure should allow sufficient time to hold discussions with those responsible for a project. This would help to better assess the projects, clarify specific issues and provide feedback to those responsible during the procedure.

#### *Requesting exchange between potential projects*

In the course of the current process, similarities in terms of subject matter as well as comparable research objectives have emerged between several projects. This applies, for example, to CREATION and GRICE-NET in the field of medical research and to KNMR and Future-NMR in the field of structure elucidation by NMR. The two astrophysical projects XLZD and LEGEND-1000 were so similar that the committee recommended them to the BMFTR as alternatives to one another (see B.I). In future, it should be possible to **facilitate and require an exchange between the project representatives** based on the declarations of interest received, even before the draft proposals are submitted. This would allow cooperation between comparable or complementary projects to be initiated at an early stage, which would promote synergies between the projects and increase the efficiency of the selection process. A conceivable time frame for this would be between the submission of declarations of interest and the deadline for submitting draft proposals. This must be taken into account in the timing of the call for draft proposals in order to allow sufficient time for the necessary exchange.

#### *Maintain financial thresholds*

The **threshold values** set in the process for initial installation costs of 50 million euros or 20 million euros for research infrastructures focusing on the SSH are still **considered appropriate**. A corresponding financial scope is inevitable for the criterion of national significance. In addition, other funding options are available for research infrastructures with lower financial requirements: for example, universities can obtain funding for research buildings or large-scale equipment with a threshold value of 5 million euros or 7.5 million euros through the joint federal and state funding programme for research buildings, large-scale equipment and national high-performance computers. |<sup>31</sup> Non-university research institutions finance research infrastructures largely from their own resources – for example, the Helmholtz Association, which finances infrastructures with funding requirements of up to 50 million euros through its

|<sup>31</sup> Joint Science Conference (GWK) (2018): Ausführungsvereinbarung zum GWK-Abkommen über die gemeinsame Förderung von Forschungsbauten, Großgeräten und des Nationalen Hochleistungsrechnens an Hochschulen; Bonn. URL: [https://www.gwk-bonn.de/fileadmin/Redaktion/Dokumente/Papers/-AV\\_FGH.pdf](https://www.gwk-bonn.de/fileadmin/Redaktion/Dokumente/Papers/-AV_FGH.pdf) (only available in German)

strategic expansion investments. |<sup>32</sup> Against this background, the thresholds set ensure a clear distinction from other funding options and continue to focus on large infrastructures.

Working groups and committees were confronted with significant differences in funding requirements between projects. In principle, a high degree of variability between cost plans for large research infrastructures is to be expected – this is already taken into account with an adjusted threshold value for the SSH. However, the fact that the funding requirements of projects can vary considerably even within the same research areas poses a challenge for the assessment process, which must weigh additional financial expenditure against the scientific added value. In doing so, the expected gains in knowledge, the size and diversity of the user communities addressed, and the contribution to the competitiveness of the German science system must be taken into account. In this process, there were both, projects with high funding requirements, whose concept convinced the committee of their appropriate proportionality in that respect, and others where this was not the case. Nevertheless, in further developing the process, it should be ensured that projects with very high funding requirements submit correspondingly more detailed concepts.

*Addressing digital and digitised research infrastructures as a desideratum*

Digital research infrastructures have a transformative character for scientific work and scientific progress. They are of great importance for the competitiveness of Germany as a research location and for the data sovereignty of Germany and Europe. The committee therefore sees a particular desideratum in the development of digital research infrastructures that correspond to the great potential of this type. It welcomes the fact that several draft proposals from different fields and disciplines have been submitted with plans for digital research infrastructures to achieve their objectives. For guidelines on the successful organisation and operation of data-intensive research, the committee refers in this context to the position paper published by the WR on the transformation of science through data-intensive research. |<sup>33</sup>

The same applies to the large number of projects submitted that have addressed the question of how the envisaged scientific achievements and their results, as well as the utilisation of research infrastructures, can be improved by digital processes and instruments. This is particularly important for the often very large amounts of data generated within research infrastructures. In order to make

|<sup>32</sup> Hermann von Helmholtz Association of German Research Centres (2021): Helmholtz Roadmap Research Infrastructures 2021; Frankfurt am Main, p. 9. URL: [https://www.helmholtz.de/system/user\\_upload/Forschung/FIS/21\\_Helmholtz\\_FIS\\_Roadmap\\_English.pdf](https://www.helmholtz.de/system/user_upload/Forschung/FIS/21_Helmholtz_FIS_Roadmap_English.pdf)

|<sup>33</sup> German Science and Humanities Council (2020): Zum Wandel in den Wissenschaften durch datenintensive Forschung | Positionspapier; Cologne. URL: <https://www.wissenschaftsrat.de/download/2020/8667-20.html> (only available in German)

this data usable in a meaningful way, technological solutions must be developed and implemented that enable careful processing, documentation, archiving and provision for external users. The projects often envisage innovative concepts for RDM, including open secondary and subsequent use, and rely on AI and ML applications.

Compared to the previous roadmap process, it is apparent that greater consideration was given to compliance with the FAIR principles, the examination of suitable systems for RDM, and the planned connection to research data infrastructures such as the NFDI. In some cases, these concepts were evaluated as remarkable. However, challenges also emerged in the design and concrete planning for the implementation of digital research infrastructures or projects with a digital focus. This includes, for example, working with extensive and sensitive research data, RDM and the use of AI. Potential for improvement was further identified in the combination of information technology and specific subject-related methods and research approaches, and in the interaction of traditions from different fields. From the committee's point of view, the NFDI, with its established structures and accumulated knowledge, offers an ideal starting point for addressing these challenges. |<sup>34</sup> NFDI consortia are already working on standards, procedures and technical solutions for many issues, so that new research infrastructure projects can rely on and build on proven expertise. The committee considers it important to keep an eye on the interoperability and sustainable usability of the emerging research infrastructures and research data.

The six recommendations mentioned above are the result of careful reflection on the now completed draft proposal phase of the national prioritisation process for research infrastructures. On the one hand, the committee sees great potential and opportunities in a continuous process with the continued support of the WR. On the other hand, it not only regards the upcoming phase of individual evaluations as part of a learning process, but also pursues the goal of further optimising the process and procedures in the future in order to be part of the further development and shaping of the German research infrastructure landscape.

|<sup>34</sup> German Science and Humanities Council (2025): Strukturevaluation der Nationalen Forschungsdateninfrastruktur (NFDI); Köln. DOI: <https://doi.org/10.57674/wcdc-6d36> (only available in German)

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# Appendix

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AI	Artificial intelligence
AIP	Leibniz-Institut für Astrophysik Potsdam Leibniz Institute for Astrophysics Potsdam
AMR	Advanced Modular Reactor
API	Application Programming Interface
ATB	Leibniz-Institut für Agrartechnik und Bioökonomie Leibniz Institute for Agricultural Engineering and Bioeconomy
ATMP	Advanced Therapy Medicinal Product
BAdW	Bayerische Akademie der Wissenschaften Bavarian Academy of Sciences and Humanities
Baikal-GVD	Baikal Gigaton Volume Detector
BESSY	Berliner Elektronen-Speicherring Gesellschaft für Synchrotronstrahlung Berlin Electron Storage Ring Society for Synchrotron Radiation
BGBM	Botanischer Garten und Botanisches Museum Berlin, Freie Universität Berlin Botanic Garden and Botanical Museum Berlin, Freie Universität Berlin
BIH	Berlin Institute of Health at Charité
BMBF	Bundesministerium für Bildung und Forschung Federal Ministry of Education and Research
BMFTR	Bundesministerium für Forschung, Technologie und Raumfahrt Federal Ministry of Research, Technology and Space
CDEX	China Dark Matter Experiment
CGT	Cell and Gene Therapy
CISPA	Helmholtz Zentrum für Informationssicherheit CISPA Helmholtz Center for Information Security
CLIO	Centre Laser Infrarouge d'Orsay
COS	TUM Center for Organoid Systems

CREATION	Center for Gene and Cell Therapy in Regeneration and Transplantation
CTC	Center for the Transformation of Chemistry
CUPID	Cuore Upgrade with Particle IDentification
DALI	Dresden Advanced Light Infrastructure
DARWIN	Dark matter wimp search with liquid xenon
DBM	Deutsches Bergbau-Museum Bochum
DESY	Deutsches Elektronen-Synchrotron German Electron Synchrotron
DKFZ	Deutsches Krebsforschungszentrum German Cancer Research Center
DKIST	Daniel K. Inouye Solar Telescope
DM	Deutsches Museum
DSA	Digital Services Act
DSM	Deutsches Schifffahrtsmuseum German Maritime Museum
DSMZ	Leibniz Institut DSMZ – Deutsche Sammlung von Mikroorganismen und Zellkulturen Leibniz Institute DSMZ – German Collection of Microorganisms and Cell Cultures
DZA	Deutsches Zentrum für Astrophysik German Center for Astrophysics
DZTO	Deutsches Zentrum für Translationale Organoidforschung The German Center for Translational Organoid Research
EBRAINS-D	EBRAINS Deutschland EBRAINS Germany
ELBE	Electron Linear accelerator with high Brilliance and low Emittance
eLTER-RI	European Long-Term Ecosystem, critical zone and socio- ecological Research Infrastructure
EMA	Ecological Momentary Assessment
ER-C	Ernst Ruska-Centrum
ESFRI	European Strategy Forum for Research Infrastructures

ESRF	European Synchrotron Radiation Facility
ESS	European Spallation Source
EST	European Solar Telescope
ET	Einstein Telescope
FAIR principles	Findable, Accessible, Interoperable, Reusable
FAU	Friedrich-Alexander-Universität Erlangen-Nürnberg
FELIX	Free Electron Lasers for Infrared eXperiments
FIZ	Leibniz-Institut für Informationsinfrastruktur Leibniz Institute for Information Infrastructure
FLASH	Free Electron Laser, Hamburg
FlexiPlant	Research Infrastructure for the Adaptive Processing of Complex Raw Materials
FRM II	Forschungs-Neutronenquelle Heinz Maier-Leibnitz Research Neutron Source Heinz Maier-Leibnitz
Future-NMR	NMR high-field spectrometer for bio- and material sciences
FZJ	Forschungszentrum Jülich
GESIS	Leibniz Institute for the Social Sciences
GeV	Giga-electronvolt
GMP	Good Manufacturing Practice
GNM	Germanisches Nationalmuseum – Leibniz- Forschungsmuseum für Kulturgeschichte
GRICE-NET	The German Research Infrastructure Network for Cell- based Medicine
GTMP	Gene Therapy Medicinal Products
GU	Goethe University Frankfurt
GUFI-14T	German Ultra-High-Field Imaging Center 14 Tesla MRI
HBP	Human Brain Project
HBS-I	High Brilliance Neutron Source – Phase I
Hereon	Helmholtz-Zentrum Hereon

HHI	Fraunhofer Institute for Telecommunications, Heinrich-Hertz-Institute
HiCANS	High-current accelerator neutron source
HMGU	Helmholtz Zentrum München Deutsches Forschungszentrum für Gesundheit und Umwelt Helmholtz Munich (Environmental Health Center)
HPC	High-performance computing
HZDR	Helmholtz-Zentrum Dresden-Rossendorf
IAP	Fraunhofer-Institut für Angewandte Polymerforschung Fraunhofer Institute for Applied Polymer Research
IBISBA	European Industrial Biotechnology Innovation and Synthetic Biology Accelerator
ICT	Fraunhofer-Institut für Chemische Technologie Fraunhofer Institute for Chemical Technology
ICT	Information and Communications Technology (in B.I.10)
IGB	Fraunhofer-Institut für Grenzflächen- und Bioverfahrenstechnik Fraunhofer Institute for Interfacial Engineering and Biotechnology
IISB	Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie Fraunhofer Institute for Integrated Systems and Device Technology
IKTS	Fraunhofer-Institut für Keramische Technologien und Systeme Fraunhofer Institute for Ceramic Technologies and Systems
ILL	Institut Laue-Langevin
IMWS	Fraunhofer-Institut für Mikrostruktur von Werkstoffen und Systemen Fraunhofer Institute for Microstructure of Materials and Systems
Instruct-ERIC	Integrated Structural Biology – European Research Infrastructure Consortium

IOF	Fraunhofer-Institut für Angewandte Optik und Feinmechanik Fraunhofer Institute for Applied Optics and Precision Engineering
IoT	Internet of Things
IPK	Leibniz-Institut für Pflanzengenetik und Kulturpflanzenforschung Leibniz Institute for Plant Genetics and Crop Plant Research
ISIS	ISIS Neutron and Muon Source
IZI	Fraunhofer-Institut für Zelltherapie und Immunologie Fraunhofer Institute for Cell Therapy and Immunology Leipzig
IZW	Leibniz-Institut für Zoo- und Wildtierforschung Leibniz Institute for Zoo and Wildlife Research
KIS	Institut für Sonnenphysik Institute of Solar Physics
KIT	Karlsruher Institut für Technologie Karlsruhe Institute of Technology
KM3NeT	Cubic Kilometre Neutrino Telescope
KNMR	Karlsruhe Nuclear Magnetic Resonance Facility
LARC	Large Animal Research and Care Center
LEAPS	League of European Accelerator-based Photon Sources
LEGEND	Large Enriched Germanium Experiment for Neutrinoless Double Beta Decay
LEIZA	Leibniz-Zentrum für Archäologie Leibniz Centre for Archaeology
LIB	Leibniz-Institut zur Analyse des Biodiversitätswandels Leibniz Institute for the Analysis of Biodiversity Change
LOP	Large Online Platform
LUMC	Leipzig University Medical Center

LUX-ZEPLIN	Large Underground Xenon - ZonEd Proportional scintillation in LIquid Noble gases
MAS	Magic-angle spinning
MDC	Max Delbrück Center for Molecular Medicine in the Helmholtz Association
MD-MAXI	The Magdeburg Center for (Bio-)Medical Advanced X-Ray Imaging
MfN	Museum für Naturkunde Leibniz Institute for Evolution and Biodiversity Science
MHH	Medizinische Hochschule Hannover Hanover Medical School
µe-Bauhaus Erlangen	Mikroelektronik-Bauhaus Erlangen
ML	Machine learning
MPIfR	Max Planck Institute for Radio Astronomy
MPIK	Max-Planck-Institut für Kernphysik Max Planck Institute for Nuclear Physics
MPINAT	Max-Planck-Institut für Multidisziplinäre Naturwissenschaften Max Planck Institute for Multidisciplinary Sciences
MPL	Max-Planck-Institut für Physik des Lichts Max Planck Institute for the Science of Light
MRI	Magnetic Resonance Imaging
MWe	megawatt electrical
MWth	megawatt thermal
MYRRHA	Multi-purpose hybrid Research Reactor for High-tech Applications
naProKi	Forschungszentrum für nachhaltige Produktion und Kreislaufwirtschaft Research Center for Sustainable Production and Circular Economy
nEXO	next Enriched Xenon Observatory
NFDI	Nationale Forschungsdateninfrastruktur German National Research Data Infrastructure

NGO	Non-Governmental Organisation
NIO	National Internet Observatory
NLP	National Laboratory for Photonic Science and Technology
NMR	Nuclear magnetic resonance spectroscopy
ORCHEStRa	Open Research Center for the Holistic Exploration of Safety and Efficiency in Real Traffic
OSIRIS	Open Science Information and Research Infrastructure
OVGU	Otto von Guericke University Magdeburg
PETRA	Positron-Elektron-Tandem-Ring-Anlage
pm rad	Picometre radiant
P-One	Pacific Ocean Neutrino Experiment
PrecFer4innoP	Precision Fermentation for innovative Products
PSI	Paul Scherrer Institute
Q-MUC	Quantum Munich Labs
R&D	Research and development
RDM	Research data management
RI	Research infrastructure
RIDLOP	Research Infrastructure for Data from Large Online Platforms
RUB	Ruhr University Bochum
RWTH Aachen	Rheinisch-Westfälische Technische Hochschule (RWTH) Aachen RWTH Aachen University
SCALA	Scale-up Green Chemistry
SGN	Senckenberg Gesellschaft für Naturforschung Senckenberg Nature Research Society
SINQ	Swiss Spallation Neutron Source
SKAO	Square Kilometre Array Observatory
SLICES-DE	Scientific Large Scale Infrastructure for Computing/Communication Experimental Studies
SMB-SPK	Staatliche Museen zu Berlin – Stiftung Preußischer Kulturbesitz

	National Museums in Berlin – Prussian Cultural Heritage Foundation
SMNK	Staatliches Museum für Naturkunde Karlsruhe State Museum of Natural History Karlsruhe
SMNS	Staatliches Museum für Naturkunde Stuttgart Stuttgart State Museum of Natural History
SNSB	Staatliche Naturwissenschaftliche Sammlungen Bayerns Bavarian Natural History Collections
SSH	Social sciences and humanities
SuperCoHD	High-Performance Computing Infrastructure for Health Data
T	Tesla
TDR	Technical Design Report
TerraNet	Toward a terrestrial digital twin of Germany for sustainable use and management of the land surface
THI	Technische Hochschule Ingolstadt
THz	Terahertz
TPP	Technology Platform Power-To-Liquid Fuels
TU Berlin	Technische Universität Berlin
TUD	Technische Universität Dresden Dresden University of Technology
TUM	Technische Universität München Technical University of Munich
TUM Hospital	University Hospital Rechts der Isar
TRL	Technology Readiness Level
U Bonn	University of Bonn
UMG	University Medical Center Göttingen
UMSICHT	Fraunhofer-Institut für Umwelt-, Sicherheits- und Energietechnik Fraunhofer Institutes for Environmental, Safety and Energy Technology
U Münster	Universität Münster

UOS	University of Osnabrück	111
USA	United States (of America)	
(U)WBG	(Ultra)wide bandgap	
WR	Wissenschaftsrat German Science and Humanities Council	
XENONnT	Direct Search for Dark Matter with Liquid Xenon Deep Underground	
XFEL	X-Ray Free-Electron Laser Röntgen-Freie-Elektronen-Laser	
XLZD	A xenon-based low-background observatory for astroparticle physics	

Figure 1:	Overview of the process with the three assessment strands	13
Figure 2:	Quantitative overview of the science-driven assessment process within the prioritisation process	15
Figure 3:	Process of the science-driven assessment by the committee of the German Science and Humanities Council	18
Figure 4:	Distribution of responsible institutions by type	20
Figure 5:	Geographical distribution of the responsible institutions	21

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