Deutsche
Forschungsgemeinschaft

Funding Atlas 2018

Key Indicators for Publicly Funded Research in Germany

WILEY-VCH

DFG

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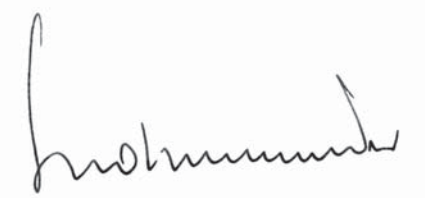
Foreword

For over twenty years, the Funding Atlas published by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) has provided information on where and to what extent research in Germany is supported by competitively acquired funding, with reference to extensive data and with meaningful differentiation. Although third-party funding accounts for only a part of the diverse research activity at German universities and non-university research institutions, in this report we aim to give a factual insight into this diversity and the specific focal areas of these institutions.

This English edition of the Funding Atlas presents selected findings from the more comprehensive German version. I would especially like to draw your attention to the section on "Research Funding in a European Context and Worldwide", which presents key aspects of international funding and research activity with an international comparison. The Excellence Initiative, for which the federal and state governments provided an additional budget of €4.3 billion for basic research between 2007 and 2017, has attracted considerable attention in Germany and internationally. The success of this initiative provided the impetus for its successor programme, the Excellence Strategy, which starting from 2019 will provide additional funding of approximately €533 million per year on a long-term basis. The decisions for the Excellence Strategy were made in September 2018 and July 2019, after the publication of the German edition of the current DFG Funding Atlas. For this English edition, we were able to include the data on these decisions in section 3.5.

The core of the Funding Atlas has always been the rankings of universities, for example with regard to the amount of third-party funding obtained from the DFG, but also, for instance, the number of international visiting researchers in a given location. However, rankings can only be understood in their specific context. So in chapter 4 of the Funding Atlas, these rankings are presented for a diverse range of subject areas. The leading institutions often vary significantly from one subject area to another. In this way, the Funding Atlas provides concrete information about the widely visible subject-based research profiles of the institutions and regions considered here, and in this English edition, this information is made available to a wider target audience.



Professor Dr. Peter Strohschneider
President of the Deutsche Forschungsgemeinschaft

1 Introduction

The Funding Atlas is characterised by three things: transparency, differentiation and continuity. It reports on the awarding of public, project-based third-party funding to universities, non-university institutions and industry as well as on key figures relating to the (international) funding of individuals. It therefore provides an almost complete overview of public third-party-funded research in Germany. The broad range of indicators used makes it possible to represent different aspects of research activity at the evaluated institutions. The analyses often provide a very detailed picture of specific subject-related characteristics. This is because over and above simple quantities, such as the volume of DFG third-party funding obtained by an institution in a given period, the Funding Atlas also provides data that illustrates which subject areas and – depending on the source – which broader themes shape an institution's profile. These profile analyses form the core of the indicator system. As the Funding Atlas has been published on a three-yearly basis for over 20 years, comparisons with previous editions make it possible to observe how the research profiles of these institutions are evolving.

The Funding Atlas is published by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation), the self-governing organisation of the research community in Germany, which primarily supports basic research in all branches of the sciences and humanities with an annual budget of more than €3 billion.

This English edition of the Funding Atlas contains selected findings from the more detailed German version. It is aimed primarily at researchers abroad and the staff of international research and funding institutions with a special interest in 'places of research' in Germany.

Reporting Concentrates on Universities and Non-university Research Institutions

The analysis in the Funding Atlas focuses on German higher education institutions, especially universities. Researchers based at universities are the main recipients of DFG funding and they also apply for the largest share of other public research funding. In terms of non-university research, the Funding Atlas focuses on Germany's major research associations, the Fraunhofer-Gesellschaft (FhG), the Helmholtz Association (HGF), the Leibniz Association (WGL) and the Max Planck Society (MPG). In this edition of the DFG Funding Atlas, fresh attention is given to the industrial sector. The chapter "Subject-based Funding Profiles of Research Institutions" contains a section on each of the four scientific disciplines, illustrating the proportion of funding obtained from the federal government and the EU in this sector.

The Funding Atlas – Data Sourced from Funding Providers, not Recipients

A large majority of the data presented on third-party funding and (international) funding for individuals originates from the funding institutions named in the Funding Atlas. The statistics generated from this data are therefore based not on complex, error-prone surveys of funding recipients, but on information extracted directly from the databases maintained by funding providers. In addition to the DFG, these include the ministries of the federal government (in particular the Federal Ministry of Education and Research and the Federal Ministry for Economic Affairs and Energy) and the EU, with data on the EU Framework Programme Horizon 2020 and the European Research Council (ERC) programme.

As indicators of the international visibility and attractiveness of institutions, data has been sourced from the Alexander von Hum-

boldt Foundation (AvH) and the German Academic Exchange Service (DAAD). As the funding profile of these organisations is geared towards the international exchange of personnel, it is not the awarded amounts which are of interest here but the number of supported research visits to Germany.

Focal Topic: Research Funding in a European Context and Worldwide

Each edition of the DFG Funding Atlas includes a special focal topic. In the last edition this included the Excellence Initiative and interdisciplinary cooperation in DFG-funded research groups. In this edition, attention is returned to a topic that was previously examined back in 2003, namely the internationalisation of research. Chapter 5 of this year's Funding Atlas focuses mainly on Europe. Data on EU funding in the Horizon 2020 programme illuminates the question of which countries are active in this programme, to what extent, and in which funding lines. The analyses show that Germany and the UK play an especially significant role in European research. This can be seen in the large number of EU projects carried out in these countries and, in particular, the fact that UK researchers are more likely than average to play the role of project coordinator. This finding suggests that the UK's announced exit from the European Union presents a particular challenge to scientific cooperation in Europe.

Additional analyses present data on the international mobility of both established and younger researchers. The Funding Atlas also examines to what extent doctoral researchers in DFG-funded Research Training Groups and Collaborative Research Centres are recruited regionally, nationally and internationally.

Excellence Strategy of the Federal and State Governments

The success of the Excellence Initiative, implemented between 2007 and 2017, which made available additional funding of around €4.3 billion, provided good reason to follow it up with the funding instrument known as the Excellence Strategy. Beginning in 2019, the federal and state governments will make an additional €533 million available for the funding of basic research on a long-term basis. The decisions relating to this funding instrument, including the funding lines of Clusters of Excellence in September 2018 and Universities of Excellence in July 2019, are presented in detail in section 3.5.

Funding Atlas Reveals Cross-institutional Cooperation in DFG-funded Programmes

As well as the subject and thematic profiles of individual universities, the context of their cooperation is an important topic of the Funding Atlas. The cartographic views in chapter 4 provide an overview of regional and cross-regional collaborations and networks, particularly between universities and non-university research institutions. These networks arise from participation in DFG Coordinated Programmes (e.g. Research Units) and Graduate Schools and Clusters of Excellence in the Excellence Initiative.

Online Material on Subject and International Profiles of Universities Substantially Expanded

The online material accompanying the DFG Funding Atlas has been further expanded. Under the heading "University views", it presents individual profile views for over 80 institutions which can also be compared in pairs with just a click. The data is represented in three different ways. The word clouds (available in German only) show which institutes have obtained DFG funding. These diagrams, with up to 150 subject areas, illustrate the diversity of many research locations but also reveal in which subject areas a university has a special focus. Secondly, a more statistically oriented view is provided by Voronoi diagrams. These show how much DFG funding a university has been awarded in the 14 different research areas, with area corresponding to proportion. Finally, ring diagrams – developed mainly with international target audiences in mind – show the most common partner countries of a university in EU-funded group projects. They show at a glance with which countries researchers at a given institution have already collaborated to a significant extent in the past.

It should be noted that the print version of the DFG Funding Atlas normally shows only the 20 to 40 universities with the highest values for any given indicator. The extensive online material supplementing the report also includes tables showing the values for other universities and for non-university research institutions.

2 Publicly Funded Research in Germany – an Overview

This chapter presents comprehensive statistics on research and development in Germany. In section 2.1, the sectors that play a significant role in the research enterprise are presented in an international comparison. This is followed by a more in-depth examination of the structure and resources of publicly funded research. The chapter concludes with a compact overview of the main public funding providers in Germany, which support the DFG Funding Atlas by making funding data available.

2.1 Expenditure on Research and Development – an International Comparison

Research and development (R&D) generates essential impetus for innovation and economic growth. This principle influenced strategic decisions in European politics from an early stage. In 2000, European heads of state and government adopted the Lisbon Strategy with the ambitious goal of making Europe "the most competitive and dynamic knowledge-based economy in the world". In 2005, the strategy was realigned after a committee of experts deemed the original objectives to be too optimistic and not achievable. Further adjustments were made in 2010 when it became the Europe 2020 Strategy, placing special emphasis on research, education and innovation – expressed in the target agreed by the EU member states of investing 3% of gross domestic product (GDP) in these areas in the medium term.[1] The Commission of Experts for Research and Innovation (EFI) set up by the federal government emphasises the importance of this goal in its 2018 Report on Research, Innovation and Technological Performance in Germany and recommends an increase to 3.5% by 2025 (EFI, 2018: 22).

Figure 2-1 shows R&D expenditure in 2015 and the proportion of gross domestic product (GDP) that it represents[2] for selected countries in Europe and the rest of the world. In this view, as in the last edition of the DFG Funding Atlas (DFG, 2015a: 22), the leading countries are the USA, China and Japan. Compared to the figures reported in the Funding Atlas 2015, there has been a noticeable increase in China's R&D expenditure: while the USA saw an increase of around 17% compared with 2011, the budget in China has almost doubled in just four years.

In 2015, measured by GDP, Germany – the economically strongest country in the European Union – nominally had the highest R&D expenditures at US$114.8 billion. Germany thus accounts for approximately 30% of the total R&D expenditure of the EU-28 countries of US$386.5 billion (OECD, 2016). It is followed by France with US$60.8 billion and the UK with US$46.3 billion. These three countries therefore represent around 57% of R&D expenditure in the European Union.

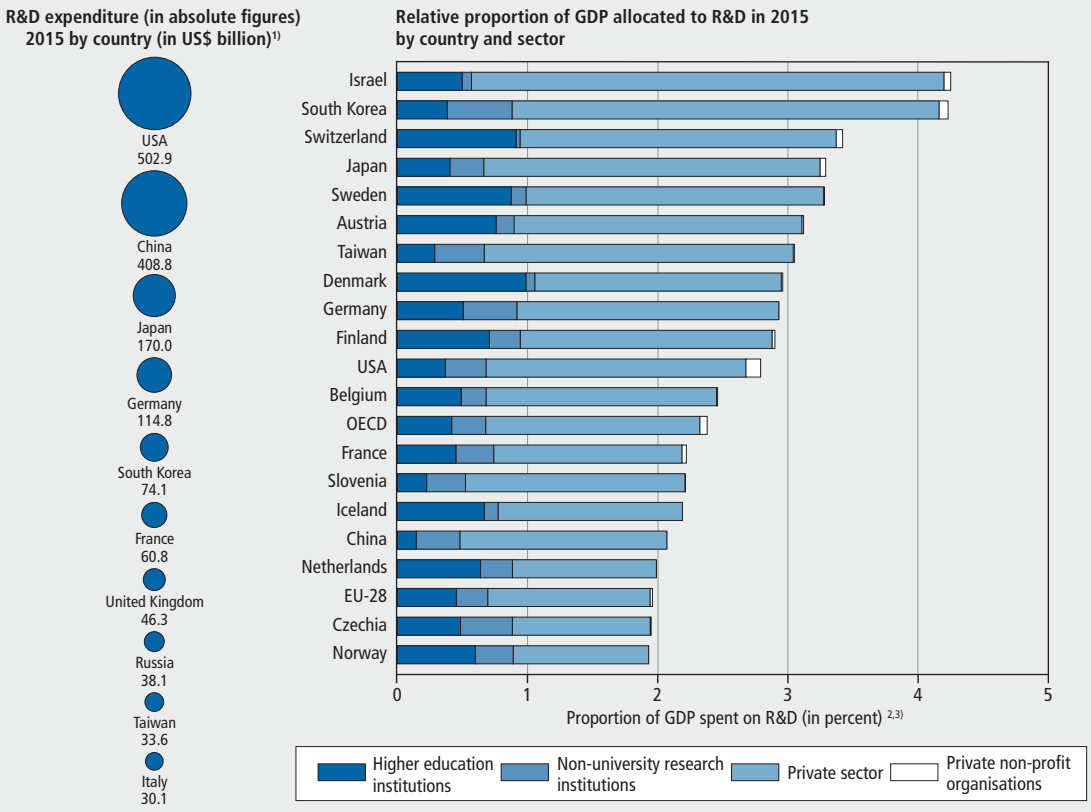
As well as comparing absolute amounts, on the right-hand side Figure 2-1 shows R&D spending as a relative proportion of GDP. It includes those OECD countries which achieved at least the threshold value of 1.8% in 2015. The diagram also shows the distribution by sector for each country.

Looking at the European countries, only Austria, Sweden and Switzerland (a non-EU country) have already clearly exceeded the 3% target to lead the ranking. Denmark, Germany and Finland are all positioned very close to the target. However, with an average of just under 2% the majority of the EU-28

1 For information on the European coordination of the 3% target, see also the interim evaluation of Horizon 2020 (European Commission, 2017: 22).

2 For the purposes of comparison, the budgets have been converted into US$ purchasing power parities in accordance with the OECD source. See also "OECD statistics" in the Glossary of Methodological Terms at www.dfg.de/fundingatlas.

Figure 2-1:
Expenditure on R&D in Germany and abroad in 2015



1) Nominal expenditure, converted to US$ purchasing power parities.
2) Includes provisional data and OECD estimates.
3) This reporting sample is restricted to countries whose expenditure on R&D was equivalent to or greater than 1.8 percent of their GDP in 2015.

Note: Corresponds to Abbildung 2-1 of the DFG Förderatlas 2018.

Data basis and source:
Organisation for Economic Co-operation and Development (OECD): Main Science and Technology Indicators 2016/2.
Calculations by the DFG.

countries are still some way off the target now set for 2020.

Taking a broader view and including the leading OECD countries, it can be seen that the OECD average for 35 countries, at 2.4%, stands 0.4 percentage points above the EU-28 average. On a global level, the EU is therefore lagging behind the OECD countries. In this relative view, the country with by far the largest investment in research and development is Israel – which is therefore a valued cooperation partner for German researchers in many different areas of research (see section 5.2). Israel is closely followed by South Korea, one of the core countries in the Asia-Pacific research area, which is regarded in the German government's High-Tech Strategy as an important target region for joint cooperation, particularly in the field of technological innovation (IIT, 2010).

Clear Differences in Sectoral R&D Participation by Country

A look at the relative proportions of R&D expenditure in 2015 by sector in the individual countries reveals a number of structural differences. The proportion of R&D expenditure represented by higher education institutions is particularly significant in Switzerland, Denmark and Sweden at over 0.8%. In Germany, the proportion represented by HEIs is approximately 0.5%, placing it at the average level for EU countries. However, with a share of around 2%, the private sector has a much more significant presence in Germany. The only other EU countries where the private sector accounts for similarly high shares of R&D spending are Sweden and Austria. Outside the EU, industry is a significant driver of R&D in Israel, South Korea and Japan.

In Germany, in addition to universities and the private sector, the non-university research sector plays an important role in R&D with publicly funded research organisations such as the Fraunhofer-Gesellschaft, the Helmholtz Association, the Leibniz Association and the Max Planck Society. With a share of 0.4%, this sector is of similarly high importance to R&D spending as universities. The only other countries with similar proportions for non-university research institutions are South Korea, Czechia and Taiwan.

Differences in sectoral participation in national research systems are discussed in more detail in section 5.2 with regard to Horizon 2020, the EU Framework Programme for Research and Innovation. This section also presents additional analysis illustrating the international dimension of research and its funding.

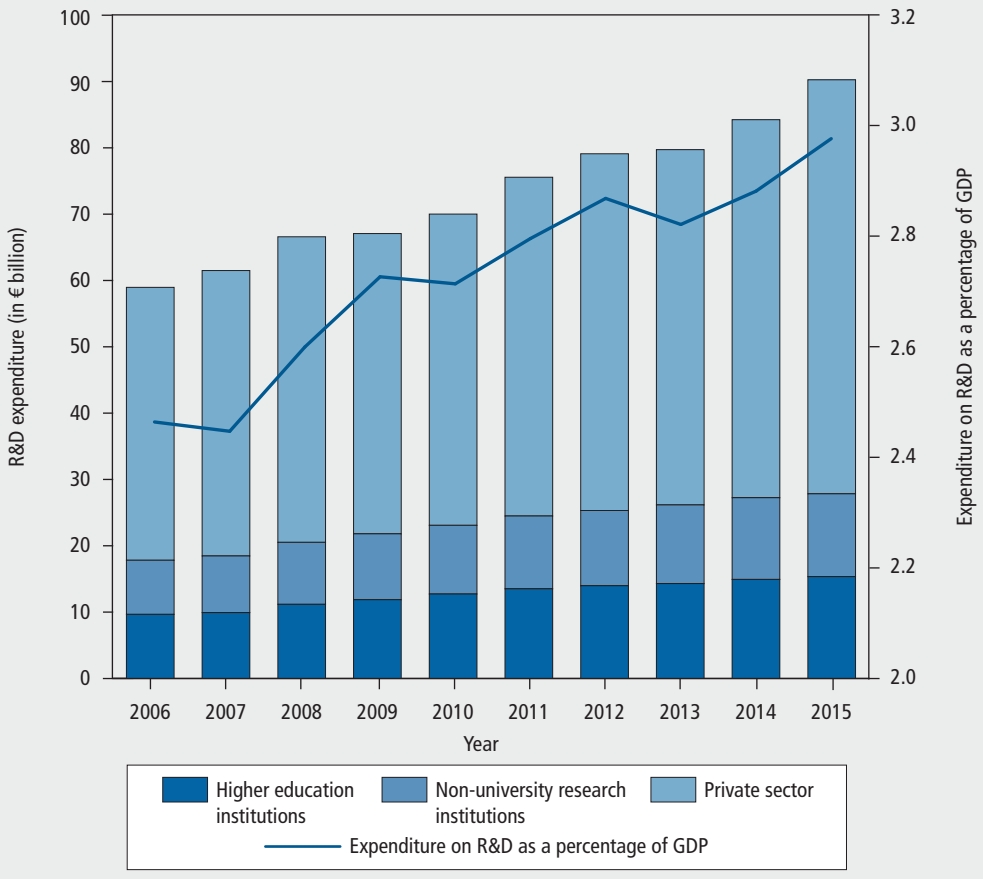
2.2 Financial and Staff Resources for German Research

Figure 2-2 shows the trend in R&D expenditure in Germany. The nominal expenditure level in 2015 was approximately €90 billion. Spending on R&D rose by €31 billion compared with 2006, an increase of more than 50%. As a result, in 2015 Germany achieved almost exactly the 3% target, with 2.98% of GDP being devoted to R&D. The sectoral distribution remained relatively constant over time.

Private Sector Accounts for 66% of R&D Expenditure in Germany

In Figure 2-3, the funding structure of German research is further broken down. The

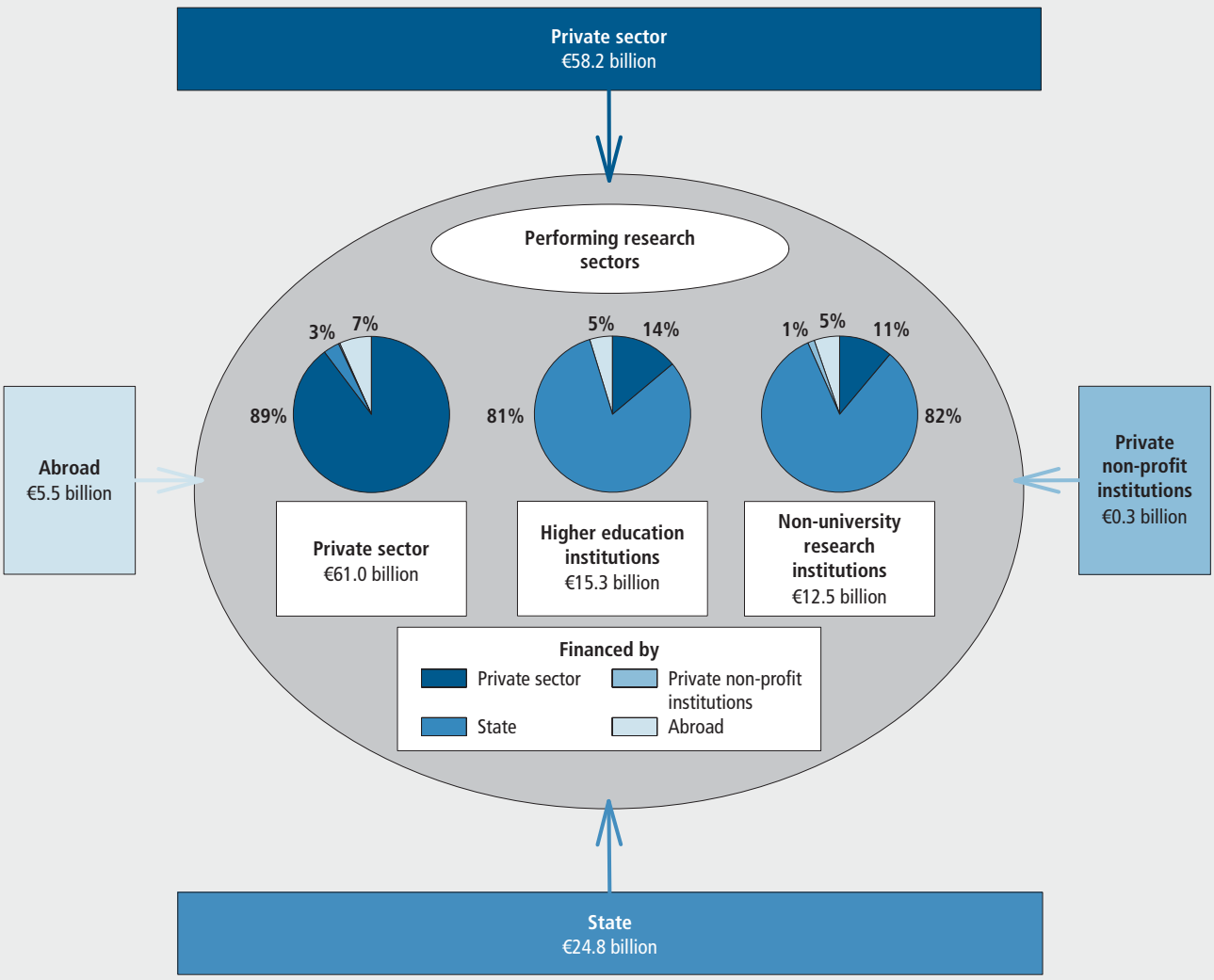
Figure 2-2:
Trend in R&D expenditure in Germany 2006 to 2015 by type of institution



Note: Corresponds to Abbildung 2-2 of the DFG Förderatlas 2018.

Data basis and source:
Federal Statistical Office (DESTATIS): Finances and Taxes. Expenditure, Revenues and Personnel of Public and Publicly Funded Institutions for Science, Research and Development 2015. Subject-Matter Series 14, Series 3.6.
Calculations by the DFG.

Figure 2-3:
Funding of German research in 2015 by sector



Note: Corresponds to Abbildung 2-3 of the DFG Förderatlas 2018.

Data basis and source:
Federal Ministry of Education and Research (BMBF): Federal Government Report on Research and Innovation 2018, Table 1.1.1.
Calculations by the DFG.

outer area of the diagram shows the sectors which provide funding. At €58.2 billion, the private sector accounts for the largest share of R&D expenditure in Germany (66%). €24.8 billion is contributed by the state, equating to a proportion of around 28%. This funding is supplemented by €5.8 billion from abroad and from other sources.

Inside the circle are shown the sectors which carry out research – the private sector, higher education institutions and non-university research institutions – with their respective funding structures. It can be seen that HEIs and non-university research institutions have very similar funding structures, with around 80% of funding coming from the state in both cases. It should be noted that the proportion of university funding provided by the private sector, at 14%, is 3 percentage points higher than the corresponding figure for non-university research institutions. So far only university spending on research and development has been examined; next university finances[3] will be considered as a whole.

In 2015, higher education institutions in Germany had a total income of €45.7 billion

3 See also "University finances" in the Glossary of Methodological Terms at www.dfg.de/fundingatlas.

Table 2-1:
DFG funding instruments: awards for the years 2014 to 2016

Funding instrument	Awards[1]	
	€m	%
Individual Grants	**2,657.5**	**31.5**
Research Grants[2]	2,327.0	27.6
Emmy Noether Programme	217.9	2.6
Heisenberg Programme	57.6	0.7
Reinhart Koselleck Projects	29.5	0.3
Clinical Trials	25.5	0.3
Coordinated Programmes	**3,566.2**	**42.3**
Research Centres	88.0	1.0
Collaborative Research Centres[3]	1,899.8	22.5
Priority Programmes	583.0	6.9
Research Units[4]	463.6	5.5
Research Training Groups	531.7	6.3
Excellence Initiative of the German federal and state governments	**1,594.6**	**18.9**
Graduate Schools	231.9	2.7
Clusters of Excellence	877.7	10.4
Institutional Strategies	485.0	5.7
Infrastructure funding[5]	**443.2**	**5.3**
Major Research Instrumentation[6]	291.6	3.5
Scientific Library Services and Information Systems	151.6	1.8
Total	**8,261.5**	**97.9**
Programmes not covered by the Funding Atlas	**177.0**	**2.1**
Prizes, other forms of funding[7]	177.0	2.1
Overall	**8,438.6**	**100.0**

[1] Including programme allowance for indirect project costs, not including non-institutional funding recipients and funding recipients abroad.
[2] Including publication grants, return grants, core facilities, workshops for early career investigators, project academies and scientific networks.
[3] Including the variation of CRC/Transregio.
[4] Including the variation of Clinical Research Units.
[5] Not including central research facilities.
[6] Including Scientific Instrumentation – Information Technology equipment initiative and major research instrumentation according to Art. 91b of the Basic Law (GG). DFG awards including applications for additional costs for procurement. Excluding state government funding.
[7] Including non-institutional funding recipients and funding recipients abroad.

Note: Corresponds to Tabelle 2-4 of the DFG Förderatlas 2018.

Data basis and source:
Deutsche Forschungsgemeinschaft (DFG, German Research Foundation): DFG awards for 2014 to 2016.
Calculations by the DFG.

for research and teaching. A large proportion of this funding comes from the ongoing basic funding provided by the federal states. There are also third-party funding and administrative revenue, in differing proportions according to the type of institution (see Table Web-38 at www.dfg.de/fundingatlas). The administrative revenues of universities come primarily from the operation of university hospitals. The corresponding revenues of selected non-university institutions for the year 2015 can be found in Table Web-39 at www.dfg.de/fundingatlas.

Universities' Third-party Funding Rate Stabilises at High Level

In recent years, as basic funding has largely stagnated or increased only slowly, third-party funding has attracted special attention from the research community and research administrators as a source of income. In the first edition of the DFG Funding Atlas in 1997, it was already noted with reference to a study by the German Council of Science and Humanities (German Council of Science and Humanities, 1993) that since the early 1980s,

universities' income from third-party funding had developed much more dynamically than basic funding (DFG, 1997: 6f.).

Over time its importance steadily rose, reaching a level that, at the height of the trend, attracted criticism in many quarters for creating what has often been referred to as third-party funding pressure.

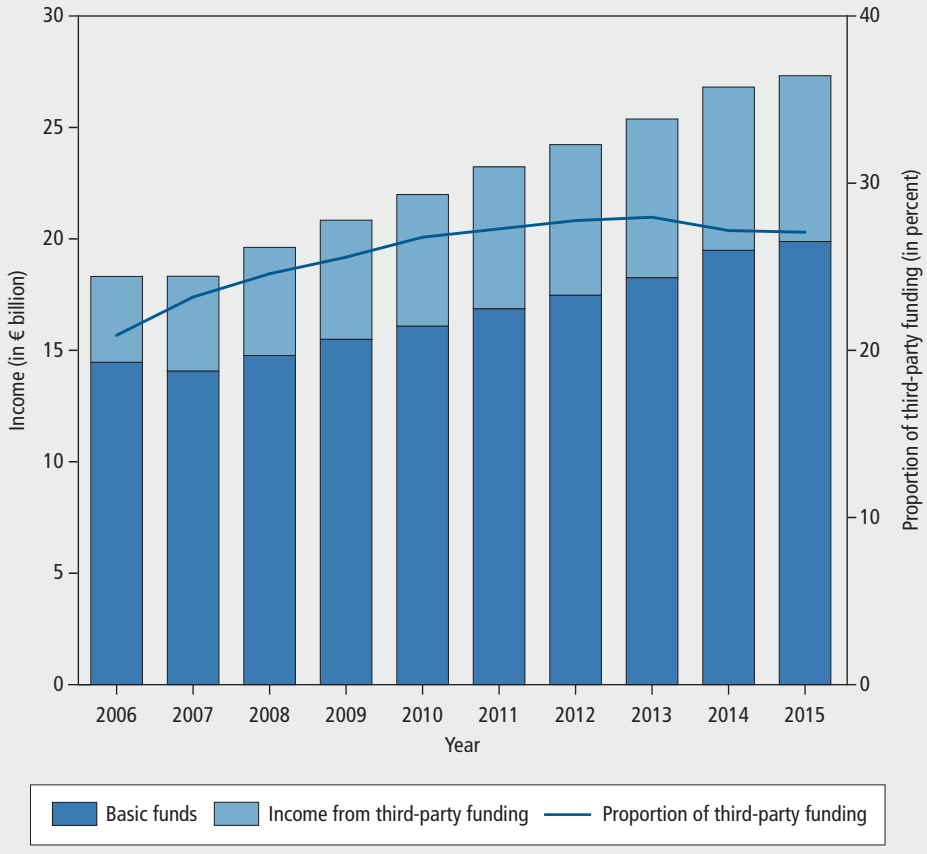
A figure that gives an indication of the relative weight of third-party funding is the 'third-party share'. To calculate this figure, the universities' administrative revenues, mainly from the operation of hospitals, are excluded and only the relationship between ongoing basic funding and acquired third-party funding is analysed.

The trend in the third-party share has been observed continuously since the 2012 edition of the DFG Funding Atlas. At that time, a value of approximately 16% was calculated for 1998, followed by a mostly continuous increase culminating in a figure of 26% for 2009, which was then the most recent reporting year. In terms of the funding volume obtained, this corresponds virtually to a doubling of third-party funding revenues in just 12 years. For basic funding, on the other hand, an increase of only 23% was calculated (DFG, 2012: 29f.).

In the time frame shown in Figure 2-4, it can be seen that the growth trend in the third-party share continued until 2013, but since then it has remained largely stable at a level between 27% and 28%. Third-party funding pressure therefore remains high, but is not continuing to increase.

This stabilisation is favoured by a new dynamic relating to basic funding. Since 2008, these rates of increase have stood at an average of 4.4% per year, while third-party funding, after an average of 9% between 2008 and 2013, experienced only very slight in-

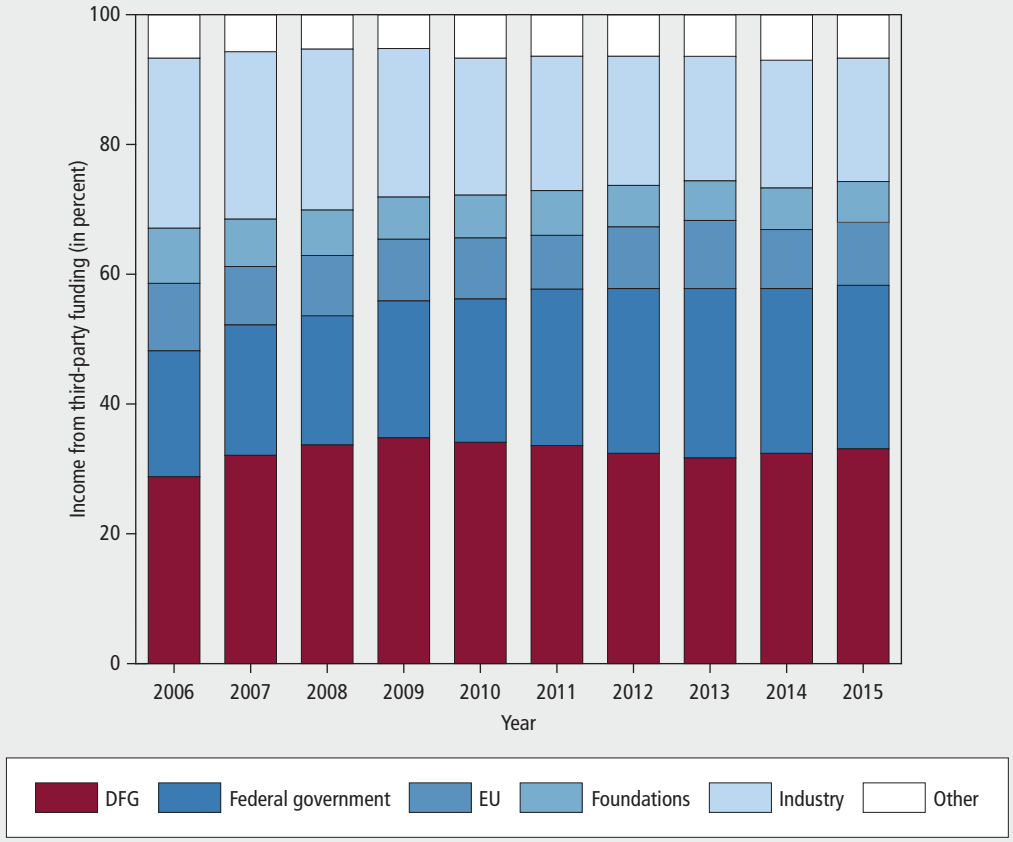
Figure 2-4:
Trend in basic and third-party funding of higher education institutions 2006 to 2015



Note: Corresponds to Abbildung 2-4 of the DFG Förderatlas 2018.

Data basis and source:
Federal Statistical Office (DESTATIS): Education and Culture. Finances of Higher Education Institutions 2015. Subject-Matter Series 11, Series 4.5. Calculations by the DFG.

Figure 2-5:
Trends in higher education institutions' income from third-party funding 2006 to 2015 by funding source



Note: Corresponds to Abbildung 2-5 of the DFG Förderatlas 2018.

Data basis and source:
Federal Statistical Office (DESTATIS): Education and Culture. Finances of Higher Education Institutions 2015. Subject-Matter Series 11, Series 4.5. Calculations by the DFG.

creases, especially in 2014 (2.8%) and 2015 (1.5%). After the rates of increase reached similar levels in 2013, with third-party funding rising by 5.4% and basic funding by 4.5%, 2014 saw a reversal of the trend: for the first time in the period under consideration, the growth in basic funding exceeded growth in third-party funding.

In 2015, universities received total ongoing basic funding of a little under €20 billion. This contrasted with third-party revenues of €7.4 billion.

An overview of the third-party revenues of individual universities can be found in Table Web-1 in the online material accompanying the Funding Atlas at www.dfg.de/funding atlas.

The DFG's Share of Universities' Third-party Funding Revenues Remains Stable

An examination of the proportions of third-party funding revenues provided by individual donors (see Figure 2-5) reveals that the DFG's share of universities' third-party funding revenues has remained stable over time at around one third. The DFG contributed its largest share in 2009 with 34.8%, while in 2015 the figure was 33.1% – despite the fact that the DFG's own budget experienced significant growth in the same period. In 2006, the DFG awarded €1.1 billion for university-based research, whereas in 2015 this figure was €2.5 billion. This budget increase was thus largely in line with the general trend.

The DFG is therefore the biggest provider of third-party funding for German universities. Following a considerable increase in the share represented by the ministries of

the federal government between 2006 and 2013, this share now stands at 25.2% – following a peak of 26.1% in 2013. After reaching a high of 10.5% in the same year, the EU's share of third-party revenues has also decreased again in the last two years, now standing at 9.7%.

Relative and Absolute Decline in Third-party Funding Revenues from Industry

In contrast, the weight of third-party funding revenues from industry has fallen steadily over time. In 2006, they represented 26.2% of total income, but in the current reporting year of 2015 they accounted for just 19%. Third-party funding from the industrial sector is the only funding source to have experienced an absolute decrease – albeit a small one – between 2014 and 2015, from €1.44 billion in 2014 to €1.41 billion in 2015.

More information on this topic is available from Stifterverband, which identified a "historic decline" in corporate third-party funding for German universities in a special analysis of data from the Federal Statistical Office (Stifterverband, 2017: 3f.). In this study, published in November 2017, this reduction is contrasted with a total increase in R&D spending by industry of 6.9% in the space of one year (2014 to 2015, from a little under €57 billion to almost €61 billion). Universities did not benefit from this increase.

Large Differences in the Importance of Third-party Funding among Non-university Research Institutions

Non-university research institutions also obtain a significant proportion of their funding from third-party sources. For the four major research organisations, the Fraunhofer-Gesellschaft (FhG), the Helmholtz Association (HGF), the Leibniz Association (WGL) and the Max Planck Society (MPG), this can be determined from data gathered as part of the reporting activities of the Joint Science Conference (GWK) on the Joint Initiative for Research and Innovation (PFI)[4]. Particularly for the institutes of the Fraunhofer-Gesellschaft, third-party funding is not a source of income that complements core support but the actual foundation for their funding, with some 68% of FhG income coming from third-party sources (see Table Web-39 at www.dfg.de/fundingatlas). Fraunhofer-Gesellschaft institutes cooperate closely with major corporations as well as with small and medium-sized enterprises (SMEs). These partners are frequently based in the region in which a Fraunhofer institute is located. In the reporting system of the Joint Initiative for Research and Innovation, it is emphasised that 60% of the companies that cooperate with Fraunhofer institutes are classified as SMEs (GWK, 2017: 13).

The third-party shares of the Helmholtz Association (just under 28%) and the Leibniz Association (just under 25%) are also significantly above the level of the universities. The Max Planck Society has a comparatively moderate third-party share of 15%.[5]

Around 300,000 Researchers Employed at Publicly Funded Research Institutions

As reported in previous editions of the DFG Funding Atlas, in the time period under consideration further growth has been recorded in the number of people employed at German higher education institutions[6] (see Table Web-40 at www.dfg.de/fundingatlas). Compared to the last DFG Funding Atlas and the year 2012, the number of staff at HEIs has grown by around 14,000 people (DFG, 2015a: 29). In 2015, there were more than 239,000 professional researchers. The majority of staff increases were recorded at universities, with the number of researchers employed there increasing by around 10,000.

In 2015, approximately 54,000 researchers were employed at non-university research institutions. The non-university organisation with the largest staff is the Helmholtz Association, which employs more than twice as many researchers as the institutes of the Fraunhofer-Gesellschaft. The other two organisations in the Joint Initiative, the Leibniz Association and the Max Planck Society, have approximately equal research workforces.

4 For more information, see www.pakt-fuer-forschung.de.

5 More detailed information on the funding structure of non-university research is available in the PFI report series (GWK, 2017a: 37ff.).

6 See also „University staff" in the Glossary of Methodological Terms in the appendix.

2.3 Funding Providers and Programmes Included in the Funding Atlas

Following the overview of financial and staff resources for German research, including an international comparison, the sections below present the key figures that are the focus of the DFG Funding Atlas. These figures are based primarily on data relating to third-party funding but also include 'head count' data, for example on the visits made by visiting researchers funded by the Alexander von Humboldt Foundation and the German Academic Exchange Service and the mobility of research staff in DFG-funded group projects.

The key figures reported in the DFG Funding Atlas cover the majority of third-party funding from public sources in Germany. The analysis focuses on the universities and the institutes of major research organisations (FhG, HGF, WGL and MPG) that apply for this type of funding. Statistics are also presented on the regionally specific acquisition of public funds. For selected funding providers (federal government and EU), these figures also include R&D funding for industry.

The main data source for the DFG Funding Atlas is the DFG's own funding database, which, in addition to the evaluations for this publication, forms the basis for a very extensive service from the DFG (by way of overview, see Figure 2-6 and www.dfg.de/zahlenfakten). The DFG institutions database[7] that forms the basis for the information system GERiT – German Research Institutions is the main tool used to link the data supplied by other funding providers and relate it to individual universities and non-university research Institutions in line with standardised criteria. The following sections describe which funding providers and instruments are covered in the DFG Funding Atlas and their specific orientation.

2.3.1 Deutsche Forschungsgemeinschaft (DFG, German Research Foundation)

The German Research Foundation is the main funding organisation for research in Germany. Its core task is to support knowledge-driven research projects conducted by researchers at universities and non-university research institutions. A self-governing organisation, in accordance with its statutes it serves "all branches of science and the humanities through the financial support of research and the promotion of national and international cooperation between researchers" (DFG, 2019: Section 1). In organisational terms, the DFG is an association under private law. Its member organisations include most German universities, non-university research institutions, scientific organisations and academies of sciences and humanities.[8] The DFG is funded by the federal and state governments, which are represented on all of its decision-making bodies, which are nonetheless mostly made up of academic representatives.

As a research funding provider, the DFG supports all academic disciplines with an annual budget which most recently amounted to approximately €3 billion (DFG, 2017a: 219). One important characteristic of DFG funding is that research projects are supported in 'response mode'. DFG funding does not concentrate on thematically focused programme lines, and all of the DFG's decisions are therefore based solely on scientific quality criteria. Scientific quality is evaluated in a multi-stage process, the initial stage of which is largely based on appraisal by expert volunteer reviewers (peer review). Every year, the expertise of some 15,000 reviewers provides an essential foundation for the decision-making process which takes place in the statutory bodies of the DFG. In the second stage, the members of the review boards elected every four years by the various scientific communities (most recently in 2015) take responsibility for the quality assurance and evaluation of the reviews and the review process as a whole, and prepare the final decision in the DFG's statutory bodies.[9] A report published by the DFG in March 2018 documents selected trends and analyses relating to the DFG review system, for example on individual review frequency, the number of women involved in the review process in different sub-

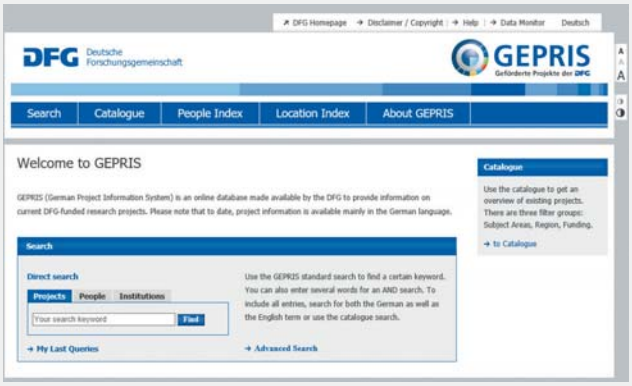
7 See also "DFG institutions database" in the Glossary of Methodological Terms in the appendix.

8 For an overview, see www.dfg.de/en/dfg_profile/statutory_bodies.

9 A detailed explanation of the work of the review boards can be found at www.dfg.de/en/dfg_profile/statutory_bodies/review_boards; an overview of the DFG's decision-making process is available at www.dfg.de/en/research_funding/proposal_review_decision/quo_vadis_proposal.

Figure 2-6
DFG information services on research funding

GEPRIS – information system for DFG-funded projects



The GEPRIS information system is an online database from the DFG that provides information about current and completed research projects. The database at gepris.dfg.de features more than 110,000 DFG-funded projects carried out by almost 70,000 researchers, working at around 30,000 institutes at universities and non-university research institutions throughout Germany. The key project aims are described by the applicants in an abstract. The information is supplemented by selected publication titles from the final project reports submitted to the DFG.

There is an English user guide to help international users search the database. For iPad users, GEPRIS is also available as a free app.

▶ **gepris.dfg.de/en**

GERiT – German Research Institutions

The information portal GERiT – German Research Institutions – provides an overview of approximately 25,000 institutes at German universities and non-university research institutions organised by subject area as well as by geographical and structural criteria. GERiT allows users to search for institutes in a particular field with the aid of a very finely structured classification system. The classification system developed by the Federal Statistical Office (DESTATIS) identifies more than 650 different subject areas. The main page for each institute listed in GERiT then provides access to more detailed information. For many universities GERiT also provides a link to the institution's own careers portal. In collaboration with the German Rectors' Conference (HRK), GERiT also indicates whether an institute offers doctoral programmes. If so, a link is provided to the university's doctoral regulations.

GERiT is primarily designed to enable students, researchers and multipliers from Germany and other countries to find German research institutions in the particular areas they are interested in.

▶ **www.gerit.org/en**

DFG annual report

As well as providing a general overview of research funding, the DFG's annual report presents extensive statistical information. The chapter "Funding activities – facts and figures" explores the distribution of DFG funding by subject area, the scope of funding within individual programmes, the participation of women in the proposal process, and trends in proposal success rates. The Annual Report therefore complements the regularly updated statistics, analyses and evaluation studies available at www.dfg.de/en/dfg_profile/facts_figures.

▶ **www.dfg.de/annual_report**

Note: Corresponds to Abbildung 2-6 of the DFG Förderatlas 2018.

ject areas, and the recruitment of international experts to evaluate DFG proposals (DFG, 2018).

DFG Funding Instruments

The funding instruments used to calculate the figures reported in the Funding Atlas cover approximately 98% of the DFG's funding volume. The analyses, like the general DFG statistics, are based on the awards approved by the DFG[10] in each funding instrument (see Table 2-4). The funding instruments mentioned here for information only, including scientific prizes, the funding of international academic contacts, and committees and commissions, are not considered in any more detail.

Individual grants are the traditional DFG instruments. The majority of funds are directed into research grants, with which researchers working individually or in small groups can fund research projects on a bottom-up basis and without specified requirements, usually for three years, at any time.

In DFG funding there is an important emphasis on Coordinated Programmes, instruments that support collaboration between researchers in various forms. A good 42% of the DFG budget is directed to the formats of Research Centres, Research Units and Collaborative Research Centres, which first and foremost provide a framework for regionally concentrated projects; Research Training Groups, which are designed to support the collaborative training of early career researchers; and Priority Programmes, in which researchers across the country work togetheron a shared research question. The funding lines of the Excellence Initiative[11] also emphasise the element of collaboration between the outstanding research institutions in a region, usually across multiple disciplinary boundaries (DFG, 2015a: 163ff.).

In 2016, as a further development of the Excellence Initiative, the federal and state governments approved the Excellence Strategy (ExStra). Section 3.5 explains in detail the decisions made in relation to the Excellence Strategy in 2018 and 2019.

10 See also „DFG funding" in the Glossary of Methodological Terms in the appendix.

11 See also „Excellence Initiative" in the Glossary of Methodological Terms in the appendix.

2.3.2 Horizon 2020 – EU Framework Programme for Research and Innovation

In the member states of the EU, national funding for research and innovation is complemented by funds from the EU Framework Programme. In 2016, just under one tenth of all public expenditure on research in the EU member states resulted from Horizon 2020 – the EU Framework Programme for Research and Innovation. Horizon 2020 will run for seven years (2014 to 2020) and has a budget of approximately €70 billion. The science policy reference framework for Horizon 2020 is provided by the Europe 2020 strategy (European Commission, 2010: 5) with the aim of increasing competitiveness, innovation potential, productivity, social cohesion and economic convergence in the EU.

Aims of the Three Pillars of Horizon 2020

The Horizon 2020 funding portfolio is divided into three pillars (Excellent Science, Industrial Leadership and Societal Challenges), and two specific objectives (Spreading Excellence & Widening Participation and Science With And For Society). The aim of the first pillar, Excellent Science, is to support excellent researchers and new fields of research, particularly through the European Research Council (ERC) and the programme line Future and Emerging Technologies (FET). High importance is also attached to the Marie Skłodowska-Curie Actions, which promote researcher mobility. This pillar also promotes transnational access to research infrastructures and preparatory measures for the establishment of new research infrastructures.

The second pillar of Horizon 2020, Industrial Leadership, is intended to support the development of technologies and innovations as the foundation for new and innovative enterprises. The focal areas of this pillar include the development of key technologies (for example, information and communication technologies), the provision of finance for research and development activities, and the fostering of innovation in SMEs.

The third pillar, Societal Challenges, covers seven social policy task areas regarded as having priority (health, food, energy, transport, environment, security and society in a chang-

ing Europe). Each task area comprises funding for both basic and applied research.

Since the programme was launched, between 2014 and 2016 approximately 14,000 agreements have been established with close to 58,000 participations from universities, non-university research institutions and businesses. The total amount calculated from the allowance agreements concluded in this period is approximately €23.7 billion. The analyses presented in this Funding Atlas are based on this data. When comparing with the figures in the DFG Funding Atlas 2015, it should be noted that the amounts there were considerably higher because they were based on all allowances for the whole of the 7th Framework Programme for Research and Technological Development (2007 to 2013). An overview of the data[12] on the EU programme Horizon 2020 used for the Funding Atlas can be found in Table Web-41 at www.dfg.de/fundingatlas.

Interim Evaluation of Horizon 2020 Shows Essential Satisfaction with the Programme

At the end of April 2017, the European Commission published the results of an interim evaluation of Horizon 2020 (European Commission, 2017: 234). The evaluation reveals essential satisfaction with the programme and emphasises the added value created by the international cooperation facilitated by Horizon 2020. The international networks resulting from this cooperation are considered separately in section 5.3 of this Funding Atlas.

Supporting Top-level Research – the European Research Council (ERC)

The European Research Council (ERC) is funded as a part of the EU Framework Programmes. In the current EU Framework Programme for Research and Innovation (2014 to 2020), approximately 17% of the total budget has been set aside for the ERC.

The aim of the main ERC programme lines (Starting Grants, Consolidator Grants and Advanced Grants) is to provide individual support to outstanding researchers. In addition, the ERC has set up Synergy Grants – initially as a pilot measure in 2012 and 2013 and again in 2018 – which enable up to four researchers to carry out an integrated research project. The ERC Starting Grant is aimed at researchers at the beginning of their careers. Researchers who have already progressed further in their careers can apply for the ERC Consolidator Grant. The ERC Advanced Grant, meanwhile, is designed for established researchers. Researchers of any nationality can apply to the ERC, but recipients of ERC grants must be based at a research location in an EU member state or an associated country (e.g. Switzerland, Norway or Israel). It is also possible to move to another research institution within Europe while in receipt of an ERC grant.

ERC funding has been analysed in the DFG Funding Atlas since the 2009 edition. For this edition, the range of analysis has been expanded in that, for the first time, the monetary figures for the ERC programme and Marie Skłodowska-Curie Actions are examined separately under the four scientific disciplines defined by the DFG and represented accordingly in chapter 4. Projects were classified under the four disciplines on the basis of information about the subject-based panels in which the individual projects were reviewed.

2.3.3 Federal Government Funding for R&D Projects

Public funding is a very important source of financial support for research and development (R&D) in Germany. State funds represent around 28% of the country's total R&D expenditure (see Figure 2-3). With respect to universities, federal government funding for R&D has increased significantly in recent years, accounting for around one quarter of universities' third-party funding volume (see section 2.2).

In addition to medium- and long-term institutional funding, where an entire research institution is supported for a longer period by the federal government or jointly by the federal and state governments, and contract research under public procurement law, federal government project funding is a particularly important source of finance for publicly funded research in Germany. Project funding is open to universities, non-university research institutions and commercial enterprises. These organisations may submit proposals for

12 See also "EU funding" in the Glossary of Methodological Terms in the appendix.

research projects with a defined time frame as part of funding and specialist programmes. Funding is offered for both individual projects and group projects involving several partners (BMBF, 2016: 55f.).

Direct project funding mostly involves specific areas of research defined in topic-based calls. Project funding in funding programmes or specialist programmes is offered for projects with a defined time frame (BMBF, 2016: 55f.). The analyses in the Funding Atlas focus on this direct project-based funding.

The data used in the Funding Atlas is taken from the PROFI database (Project Funding Information System) maintained by the Federal Ministry of Education and Research (BMBF), which covers most of the federal government's direct project funding in the civilian sector.[13] In addition to BMBF funding measures, funding programmes of other ministries are also recorded – in particular those of the Federal Ministry for Economic Affairs and Energy (BMWi), the Federal Ministry of Transport and Digital Infrastructure (BMVI), the Federal Ministry of Food and Agriculture (BMEL) and the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB). In total, the funds from this source recorded in the Funding Atlas amount to around €8.9 billion.

Improved Coverage of Federal Funding through Complete Integration of ZIM Programme

The coverage of the figures reported in relation to federal funding (see Table Web-42 at www.dfg.de/fundingatlas) has been improved compared with the DFG Funding Atlas 2015. The BMWi funding programme known as the Central Innovation Programme for SMEs (ZIM), with a funding volume of €1.6 billion between 2014 and 2016, has now been added, classified into the funding areas listed there according to the content focus of the funded measures.

The Central Innovation Programme for SMEs (ZIM) is a funding programme aimed at small and medium-sized enterprises with no specified requirements as to technology or sector. It is divided into three funding lines: individual projects, cooperation projects and cooperation networks. Universities and research institutions mainly participate in the cooperation projects funding line. The clear increase in overall volume compared with the values reported in the 2015 Funding Atlas (DFG, 2015a: 45) is primarily due to this improved coverage.[14]

2.3.4 Alexander von Humboldt Foundation (AvH)

The Alexander von Humboldt Foundation supports scientific collaborations between excellent researchers in Germany and abroad. In its funding programmes, the AvH sponsors both research fellowships and research awards. The most important selection criterion applied by the AvH is evidence of a high level of individual qualification. Funding is awarded to the best researchers, whether established or at an early stage in their careers, and regardless of regional origin or discipline. In contrast to the funding providers discussed so far, the AvH awards funding to individuals and not projects. As well as financial allowances, the support offered includes comprehensive alumni support.

The AvH supports all academic career stages: postdoctoral researchers, leaders of independent junior research groups, experienced researchers and leading scholars of international reputation.

The AvH is funded by awards from the Federal Foreign Office, the Federal Ministry of Education and Research (BMBF), the Federal Ministry for Economic Cooperation and Development (BMZ), the Federal Ministry for the Environment, Nature Conservation, Housing and Nuclear Safety (BMUB), other national and international partners, and proceeds from donated assets. In 2016, the expenditure of the AvH was approximately €116 million (AvH, 2017: 39).

AvH Fellowships for Research in Germany

Researchers from other countries are eligible to apply for AvH fellowships. These fellowships are aimed at postdoctoral researchers and also experienced researchers who earned

13 See also www.foerderkatalog.de.

14 In the DFG Funding Atlas 2015, part of the ZIM funding was still reported separately. See also "Federal funding" in the Glossary of Methodological Terms in the appendix.

their doctorates some time ago and who are usually already working as a research assistant, junior research group leader or professor. Fellowship recipients not only choose their own research topic but also select the most suitable host institution in Germany.

AvH Awards for Outstanding Researchers

The Alexander von Humboldt professorship encourages world-leading researchers to work in Germany on a long-term basis. Individuals are nominated by German universities and must be integrated in a strategic concept. The award is worth €3.5 to €5 million and enables an individual to carry out research in Germany for five years. Distinguished early career researchers can apply for the Sofja Kovalevskaja Award in order to build up a working group and spend five years working on a research project of their own choice at a research institution in Germany. AvH funding programmes also include numerous other awards and fellowships for research visits to Germany.[15]

In this edition of the DFG Funding Atlas, data on AvH funding recipients forms a key pillar of the focal topic "Research Funding in a European Context and Worldwide" (see chapter 5). For an overview of the data basis used in the DFG Funding Atlas[16], see Table Web-43 at www.dfg.de/fundingatlas.

2.3.5 German Academic Exchange Service (DAAD)

The German Academic Exchange Service, like the DFG, is an association under private law. It is one of the largest organisations in the world supporting international exchanges for students and researchers. Most of the DAAD budget is funded by ministries of the federal government, for example the Federal Foreign Office, the Federal Ministry of Education and Research (BMBF) and the Federal Ministry for Economic Cooperation and Development (BMZ). Another important funding provider is the European Union. In 2016, the DAAD budget was approximately €500 million (DAAD, 2017: 10).

DAAD Online Resource on Fellowship-funded Research Visits

The main services offered by the DAAD include the awarding of fellowships to students, graduates and researchers. The DAAD offers around 130 fellowships which are available to individuals from all countries and in all subject areas. A general overview is provided by the DAAD fellowship database[17]. It is aimed particularly at international students, graduates and researchers and covers a wide range of fellowships for studying, teaching and researching in Germany. In addition to DAAD funding opportunities, this searchable database includes fellowships offered by other providers such as Stiftung der Deutschen Wirtschaft and the Volkswagen Foundation. In addition to individual funding, an essential task of the DAAD is to strengthen the internationalisation of German universities through institutional funding (project funding). More information about the DAAD funding portfolio can be found in the detailed overviews in the DAAD annual report (DAAD, 2017: 72ff.).

For the comparative analyses of funding-based figures in the chapters that follow, only established researchers are taken into account. Together with recipients of AvH and ERC funding, this provides a suitable indicator of the attractiveness of German research institutions in the global scientific community. Table Web-44 at www.dfg.de/fundingatlas shows both this data basis and the countries of origin of DAAD-funded graduates.[18]

15 See www.humboldt-foundation.de.

16 See also „AvH funding" in the Glossary of Methodological Terms in the appendix.

17 See www.daad.de/deutschland/stipendium/datenbank/en/21148-stipendiendatenbank.

18 See also „DAAD funding" in the Glossary of Methodological Terms in the appendix.

3 Institutions and Regions of Research in Germany

This chapter presents, firstly, an overview of the locations of universities and non-university institutions, thus providing a picture of the spatial distribution of German research facilities. This is followed by an analysis of these institutions' participation in the programmes of the various funding providers, with an emphasis on funding instruments offered by the DFG. For the institution-specific views, the printed version of the Funding Atlas normally concentrates on the 20 to 40 universities with the highest award volumes. Additional evaluations of other universities and non-university institutions are available at www.dfg.de/fundingatlas. As well as institutions, this chapter also examines in the familiar form the different regions in research. For this edition, this is supplemented for the first time by a comprehensive interactive map in the online version. The map view allows the user to compare the profiles of different regions in their chosen funding or subject areas.

Like previous editions, this DFG Funding Atlas includes a number of special analyses. In this chapter, the 50th anniversary of Collaborative Research Centres provides an ideal opportunity to focus on this funding instrument.

This chapter also presents in detail the decisions made in the Excellence Strategy, which has attracted considerable international attention (see section 3.5).

3.1 Locations and Structure of Research in Germany

Germany's research landscape is diverse and not concentrated in a small number of locations. This is illustrated in map form in Figure 3-1. The map shows the main locations of 430 higher education institutions (96 universities, 251 HEIs without the right to confer doctorates, and 83 schools of theology, teacher training, music and art), 283 institutes of the Fraunhofer-Gesellschaft (FhG), the Helmholtz Association (HGF), the Leibniz Association (WGL) and the Max Planck Society (MPG), 50 federal research institutions and five international research organisations such as the **European Molecular Biology Laboratory (EMBL)** in Heidelberg.

The map representation is based on the DFG's institutions database, part of which is available online under the name GERiT. In addition to the institutions shown in Figure 3-1, it covers close to 300 state research institutions, libraries, archives, collections and academies of sciences and humanities. The database offers a range of search options and for each university in Germany it lists not only the institution itself but also every institute within it (see Figure 2-6).

The analyses presented below also benefit significantly from the indexed information in the DFG institutions database[1], which provides addresses and subject classifications for more than 25,000 institutions and their subunits. For the institution as a whole, the database also specifies to which institution type it belongs (e.g. university, university of applied science or Max Planck Institute). The classification system used was also applied to the data on federal R&D funding and Horizon 2020 funding, with the addition of the Industry category, which plays an important role for both funding providers.

Clear Differences among Research Funding Providers in Institution-specific Demand

Table 3-1 shows, in the form familiar from the last Funding Atlas, how the various types of institutions participate in DFG, federal government and EU funding programmes. A distinction is made between higher education

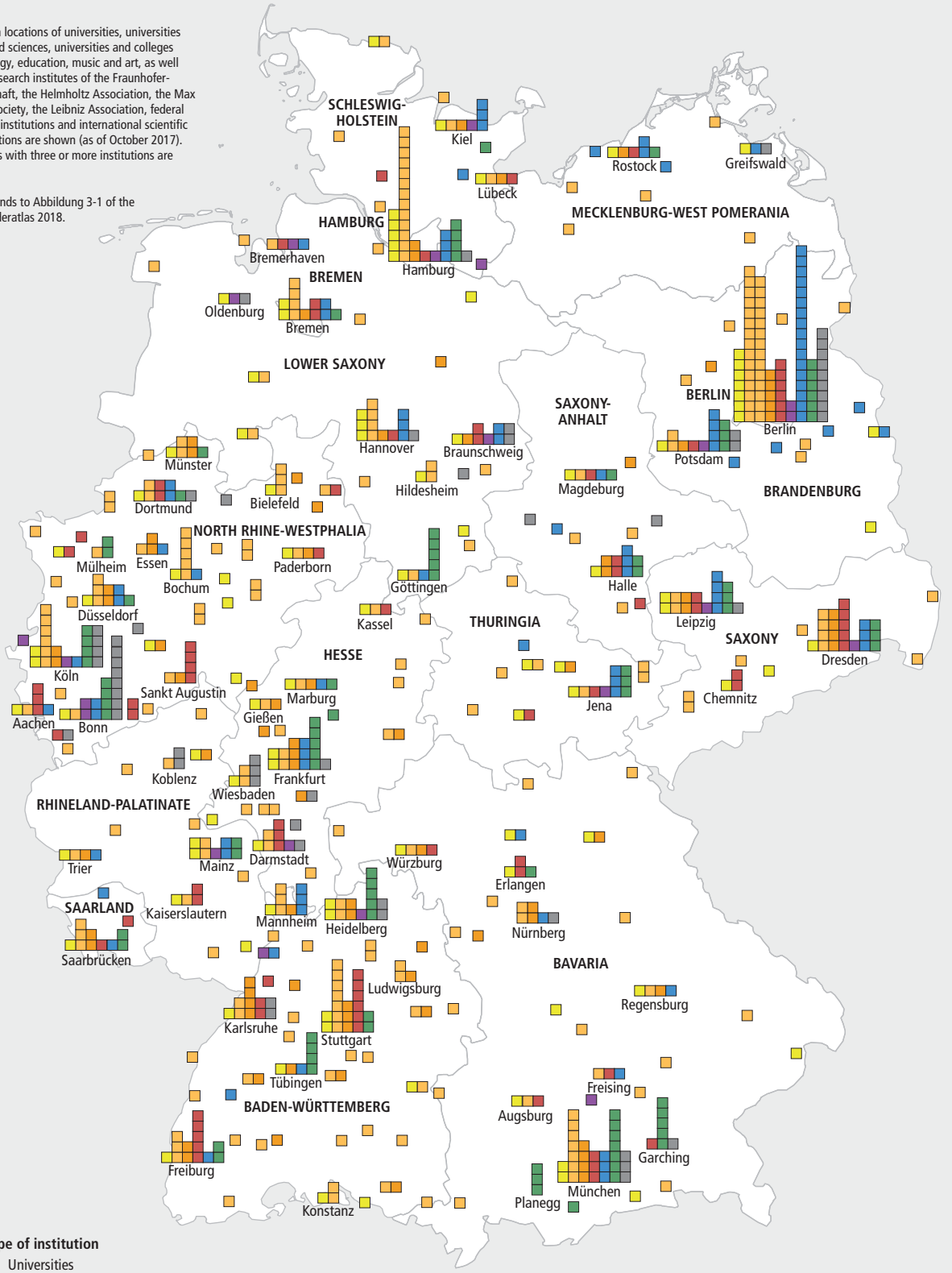
1 See also "DFG institutions database" in the Glossary of Methodological Terms at www.dfg.de/fundingatlas.

Figure 3-1:
Locations of research institutions in Germany 2017

Notes:

The main locations of universities, universities of applied sciences, universities and colleges of theology, education, music and art, as well as the research institutes of the Fraunhofer-Gesellschaft, the Helmholtz Association, the Max Planck Society, the Leibniz Association, federal research institutions and international scientific organisations are shown (as of October 2017). Locations with three or more institutions are named.

Corresponds to Abbildung 3-1 of the DFG Förderatlas 2018.



Type of institution

- Universities
- Universities of applied sciences
- Universities and colleges of theology, music and art
- Fraunhofer-Gesellschaft (FhG)
- Helmholtz Association (HGF)
- Leibniz Association (WGL)
- Max Planck Society (MPG)
- Federal research institutions and international scientific organisations

Table 3-1:
Participation[1] in DFG, federal government and EU funding programmes for research by type of institution

Type of institution	DFG awards		Direct R&D project funding from the federal government		Funding under the AiF's IGF programme		R&D funding in Horizon 2020	
	€m	%	€m	%	€m	%	€m	%
Higher education institutions	**7,310.2**	**88.5**	**4,019.3**	**38.3**	**212.8**	**50.8**	**1,220.9**	**31.0**
Non-university research institutions	**951.3**	**11.5**	**3,047.2**	**29.0**	**199.7**	**47.7**	**1,608.0**	**40.8**
Fraunhofer-Gesellschaft (FhG)	25.2	0.3	826.0	7.9	50.4	12.0	252.6	6.4
Helmholtz Association (HGF)	193.7	2.3	635.4	6.0	1.1	0.3	348.5	8.8
Leibniz Association (WGL)	213.9	2.6	251.8	2.4	6.8	1.6	93.6	2.4
Max Planck Society (MPG)	253.8	3.1	170.4	1.6	0.4	0.1	463.0	11.8
Federal research institutions	48.3	0.6	155.3	1.5	4.5	1.1	67.7	1.7
Other research institutions	216.3	2.6	1,008.3	9.6	136.5	32.6	382.6	9.7
Industry and commercial enterprises			**3,439.1**	**32.7**	**6.1**	**1.5**	**1,108.9**	**28.2**
Overall	**8,261.5**	**100.0**	**10,505.6**	**100.0**	**418.6**	**100.0**	**3,937.8**	**100.0**

[1] Funding for German and institutional recipients only.

Note: Corresponds to Tabelle 3-1 of the DFG Förderatlas 2018.

Data basis and sources:
Deutsche Forschungsgemeinschaft (DFG, German Research Foundation): DFG awards for 2014 to 2016.
EU Office of the BMBF: Participation in Horizon 2020. EU Framework Programme for Research and Innovation (project data as of 28 February 2017).
Federal Ministry for Economic Affairs and Energy (BMWi): Funding for the Central Innovation Programme for SMEs (ZIM) 2014 to 2016.
Federal Ministry of Education and Research (BMBF): Direct R&D project funding from the federal government 2014 to 2016 (PROFI project database).
German Federation of Industrial Research Associations (AiF): Funding for Industrial Collective Research (IGF) 2014 to 2016.
Calculations by the DFG.

institutions, non-university research institutions and industry, with the second category being broken down into the non-university research organisations named above. The distinctive profile of DFG funding is immediately apparent. It concentrates on research at universities, which have accounted for a stable share of around 89% for many years. The remainder goes to non-university institutions. Research projects based in commercial enterprises are not eligible for DFG funding, but they are funded by the federal government and the EU, with around 30% of the funding volume in each case being invested in commercial research. In the case of the federal government, this amounts to just under €3.5 billion over three years (2014 to 2016), and for the EU's Horizon 2020 programme over €1 billion, also over a three-year period.

While the share of funding awarded to industry by both funding providers has remained relatively stable compared with the Funding Atlas 2015, and for the federal government has also changed little in relation to higher education institutions and non-university institutions, a shift can be observed in the case of the EU. While close to 38% of all funds awarded to Germany in the 7th Framework Programme for Research and Technological Development went to universities, this figure is now just 31%. The amount allocated to non-university institutions has seen a corresponding increase, and at 41% these now account for the largest proportion of Horizon 2020 funding (previously 36%). This increase is due in large part to the Max Planck Society, which exactly doubled its share to 11.8%.

The amount of third-party funding awarded to different types of institutions by the federal government and the EU can be seen in Tables Web-23 to Web-28 at www.dfg.de/fundingatlas, differentiated into individual universities and non-university research institutions.

Considerable Stability in Preferences for Research Visits by AvH- and ERC-funded Leading Researchers

The Funding Atlas uses two key figures to evaluate the international attractiveness of institutions and their success in the international competition to conduct top-level research. It refers firstly to the number of researchers who completed a longer research visit at a location with funds from the Alexander von Humboldt Foundation (AvH) and secondly to the number of persons who were awarded a Starting Grant, Consolidator Grant

Table 3-2:
Number of AvH and ERC funding recipients by type of institution

Type of institution	AvH funding recipients		ERC funding recipients[1)]	
	N	%	N	%
Higher education institutions	**4,471**	**75.8**	**297**	**65.1**
Non-university research institutions	**1,430**	**24.2**	**159**	**34.9**
Fraunhofer-Gesellschaft (FhG)	28	0.5	1	0.2
Helmholtz Association (HGF)	210	3.6	44	9.6
Leibniz Association (WGL)	258	4.4	12	2.6
Max Planck Society (MPG)	721	12.2	84	18.4
Federal research institutions	71	1.2		
Other research institutions	142	2.4	18	3.9
Overall	**5,901**	**100.0**	**456**	**100.0**

[1)] ERC funding recipients in Germany are shown.

Note: Corresponds to Tabelle 3-2 of the DFG Förderatlas 2018.

Data basis and sources:
Alexander von Humboldt Foundation (AvH): Research visits by AvH guest researchers from 2012 to 2016.
EU Office of the BMBF: ERC funding in Horizon 2020. EU Framework Programme for Research and Innovation (project data as of 10 October 2017).
Figures include Starting Grants, Advanced Grants and Consolidator Grants.
Calculations by the DFG.

or Advanced Grant by the European Research Council (ERC).

As in the reporting period for the Funding Atlas 2015 (DFG, 2015a: 57) and in the 2012 edition (DFG, 2012: 67), between 2012 and 2016, three out of four AvH funding recipients chose higher education institutions for their research visits. Among non-university institutions, the institutes of the MPG were the most favoured destination for visiting researchers funded by the Alexander von Humboldt Foundation (see Table 3-2).

The distribution of ERC funding recipients has remained similarly stable over time. Two out of three of the internationally renowned researchers awarded an ERC grant carry out their research project at a higher education institution. And as with AvH funding, the MPG attracts the second highest number of ERC grantees. A good 18% of them choose a Max Planck Institute, with just under 10% opting for an HGF institute. Tables Web-27 and Web-29 at www.dfg.de/fundingatlas show detailed information about recipients of AvH and ERC funding by university.

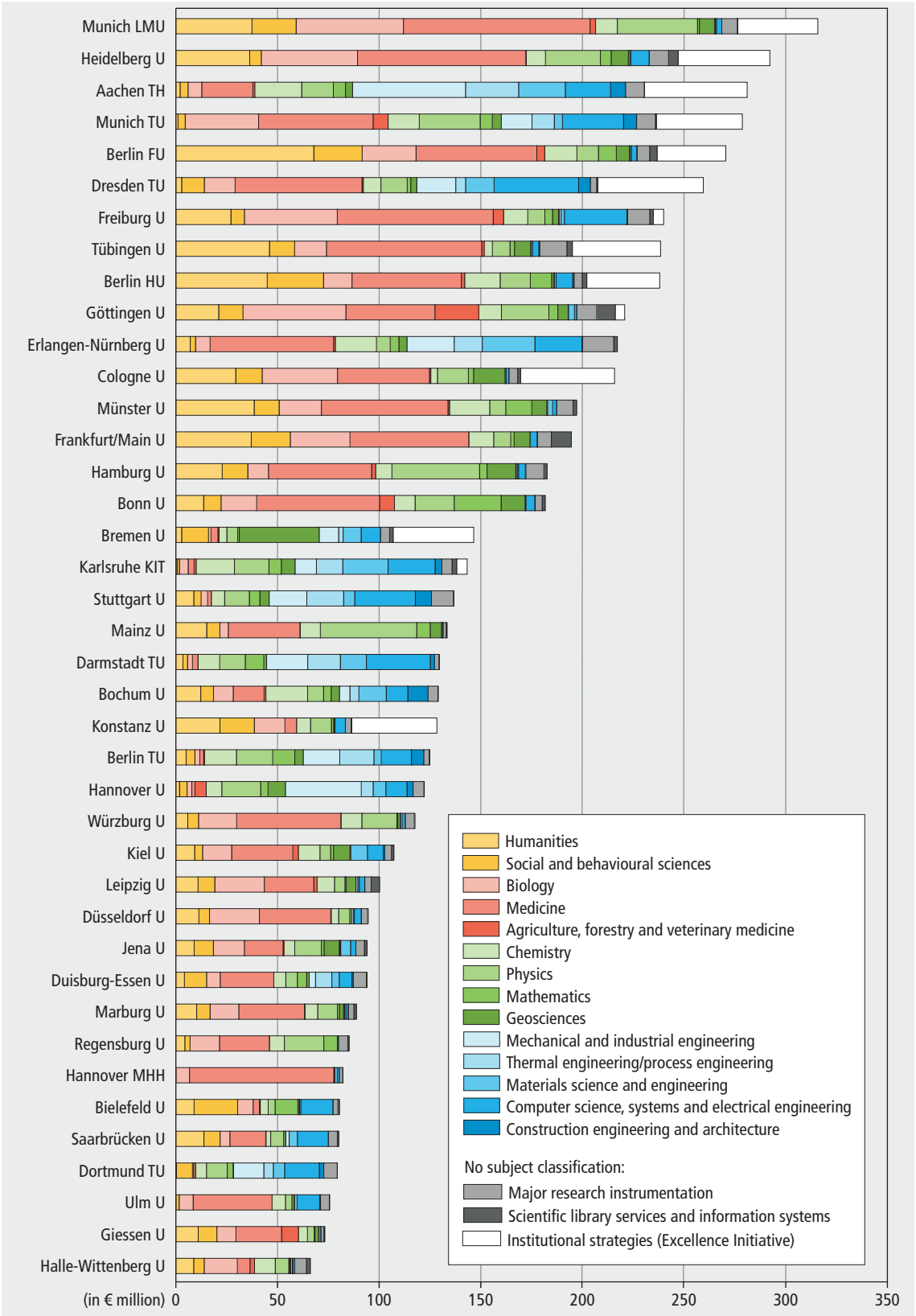
3.2 DFG Awards to Universities

The role of third-party funding from the DFG varies from one university to another, in both relative and absolute terms. Figure 3-2 shows this in the form of a bar chart arranged by volume for the 40 universities with the greatest amount of third-party funding. In the online material complementing the DFG Funding Atlas, Tables Web-7 to Web-12 also show all universities and Table Web-19 all non-university research institutions which received more than €1 million in awards in the period under consideration.

Remarkable Stability in Absolute Ranking of DFG Awards by University

The ranking shows a remarkable stability, particularly among the universities that attract the largest volume of funding. In eight cases, the top 10 consists of the same universities as in 2015, with the ranking actually being identical in the top five positions. This makes the few changes all the more notable. **TU Dresden**, which was noted in the Funding Atlas 2012 for its „exceptional development“ due to steady growth in third-party funding (DFG, 2012: 73) and which joined the top ten DFG-funded universities for the first time in 2015, has made further progress, rising four places to occupy 6th place. Another university which has risen in the ranking is **U Tübingen**, which now occupies 8th place compared with 14th place in the last two DFG Funding Atlases. It is also notable that a change has taken place at the top of the table, not in terms of the ranking per se but in terms

Figure 3-2:
DFG awards for 2014 to 2016 by higher education institution and research area[1)]



Note: Corresponds to Abbildung 3-3 of the DFG Förderatlas 2018.

[1)] Only the 40 leading recipients (HEIs) of DFG awards are presented here.

Data basis and source:
Deutsche Forschungsgemeinschaft (DFG, German Research Foundation): DFG awards for 2014 to 2016.
Calculations by the DFG.

Table 3-3:
The higher education institutions with the highest DFG awards for 2014 to 2016 – overall and by scientific discipline

DFG awards[1]		Humanities and social sciences[2]		Life sciences[2]		Natural sciences[2]		Engineering sciences[2]	
Higher education institution	€m	**Higher education institution**	€m	**Higher education institution**	€m	**Higher education institution**	€m	**Higher education institution**	€m
Munich LMU	315.8	Berlin FU	91.6	Munich LMU	147.3	Mainz U	69.6	Aachen TH	134.3
Heidelberg U	292.2	Berlin HU	72.6	Heidelberg U	130.3	Hamburg U	68.9	Erlangen-Nürnberg U	86.4
Aachen TH	281.0	Munich LMU	59.1	Freiburg U	127.5	Bonn U	64.2	Dresden TU	85.4
Munich TU	278.7	Tübingen U	58.4	Göttingen U	116.0	Munich LMU	58.6	Darmstadt TU	82.5
Berlin FU	270.5	Frankfurt/Main U	56.3	Munich TU	99.8	Munich TU	55.7	Stuttgart U	79.8
Dresden TU	259.4	Münster U	50.8	Tübingen U	93.3	Heidelberg U	50.3	Karlsruhe KIT	72.2
Freiburg U	239.9	Cologne U	42.4	Berlin FU	89.8	Bremen U	49.2	Munich TU	66.6
Tübingen U	238.4	Heidelberg U	42.0	Frankfurt/Main U	87.8	Karlsruhe KIT	48.6	Hannover U	62.8
Berlin HU	238.0	Konstanz U	38.6	Bonn U	85.3	Berlin TU	48.6	Berlin TU	59.3
Göttingen U	220.8	Hamburg U	35.4	Münster U	83.9	Aachen TH	48.1	Dortmund TU	44.5
Erlangen-Nürnberg U	217.1	Freiburg U	33.7	Cologne U	83.0	Münster U	47.8	Bochum U	43.6
Cologne U	215.8	Göttingen U	33.0	Dresden TU	78.2	Göttingen U	44.0	Chemnitz TU	39.3
Münster U	197.1	Bielefeld U	30.4	Hannover MHH	77.8	Berlin HU	43.9	Freiburg U	34.0
Frankfurt/Main U	194.5	Mannheim U	27.6	Würzburg U	70.0	Berlin FU	41.7	Braunschweig TU	33.0
Hamburg U	182.6	Bonn U	22.2	Berlin HU	69.4	Hannover U	39.0	Bremen U	30.1
Bonn U	181.7	Saarbrücken U	21.7	Erlangen-Nürnberg U	68.7	Cologne U	36.5	Kaiserslautern TU	28.2
Bremen U	146.5	Mainz U	21.6	Hamburg U	62.9	Bochum U	36.2	Freiberg TU	27.6
Karlsruhe KIT	143.3	Giessen U	20.2	Düsseldorf U	59.8	Erlangen-Nürnberg U	35.3	Duisburg-Essen U	21.6
Stuttgart U	136.7	Leipzig U	19.2	Leipzig U	50.3	Darmstadt TU	33.8	Hamburg TU	21.5
Mainz U	133.4	Bochum U	18.5	Kiel U	47.1	Regensburg U	33.7	Saarbrücken U	21.0
Darmstadt TU	129.5	Jena U	18.5	Marburg U	46.6	Frankfurt/Main U	30.1	Magdeburg U	18.1
Bochum U	129.0	Potsdam U	18.3	Ulm U	45.7	Würzburg U	29.2	Paderborn U	17.9
Konstanz U	128.4	Marburg U	16.8	Giessen U	40.1	Stuttgart U	28.5	Ilmenau TU	17.8
Berlin TU	124.9	Düsseldorf U	16.5	Mainz U	39.4	Jena U	27.2	Kiel U	17.1
Hannover U	122.2	Bremen U	16.0	Regensburg U	39.0	Freiburg U	27.1	Bielefeld U	17.0
Würzburg U	117.5	Duisburg-Essen U	15.1	Lübeck U	36.6	Dresden TU	26.3	Siegen U	15.4
Kiel U	107.2	Dresden TU	14.0	Jena U	34.7	Kiel U	25.4	Ulm U	13.1
Leipzig U	100.2	Halle-Wittenberg U	13.9	Duisburg-Essen U	33.1	Bayreuth U	24.2	Rostock U	12.1
Düsseldorf U	94.6	Kiel U	13.1	Aachen TH	32.8	Tübingen U	22.9	Clausthal TU	11.6
Jena U	94.1	Stuttgart U	12.4	Bochum U	25.8	Kaiserslautern TU	20.3	Kassel U	10.8
Duisburg-Essen U	94.0	Bamberg U	12.2	Halle-Wittenberg U	24.8	Leipzig U	19.1	Heidelberg U	10.2
Marburg U	88.8	Würzburg U	11.1	Magdeburg U	24.7	Marburg U	19.0	Berlin HU	9.9
Regensburg U	85.2	Oldenburg U	10.5	Saarbrücken U	22.6	Bielefeld U	18.7	Oldenburg U	8.8
Hannover MHH	82.1	Siegen U	9.9	Konstanz U	20.7	Potsdam U	18.7	Bayreuth U	8.6
Bielefeld U	80.4	Erlangen-Nürnberg U	9.7	Oldenburg U	18.6	Dortmund TU	18.6	Jena U	8.2
Saarbrücken U	80.1	Trier U	9.6	Greifswald U	16.5	Konstanz U	18.5	Weimar U	7.5
Dortmund TU	79.4	Berlin TU	9.4	Osnabrück U	13.2	Halle-Wittenberg U	17.5	Cottbus-Senftenberg TU	7.4
Ulm U	75.6	Bayreuth U	8.9	Hohenheim U	11.2	Duisburg-Essen U	17.4	München UdBW	6.7
Giessen U	73.2	Chemnitz TU	8.5	Bielefeld U	11.1	Paderborn U	13.6	Wuppertal U	5.9
Halle-Wittenberg U	66.1	Dortmund TU	8.1	Potsdam U	11.1	Rostock U	13.0	Konstanz U	5.5
Ranked 1–40	**6,335.9**	**Ranked 1–40**	**1,048.0**	**Ranked 1–40**	**2,276.4**	**Ranked 1–40**	**1,388.8**	**Ranked 1–40**	**1,303.4**
Other HEIs[3]	**974.4**	**Other HEIs[3]**	**132.8**	**Other HEIs[3]**	**86.0**	**Other HEIs[3]**	**134.8**	**Other HEIs[3]**	**89.1**
HEIs overall	**7,310.2**	**HEIs overall**	**1,180.8**	**HEIs overall**	**2,362.4**	**HEIs overall**	**1,523.6**	**HEIs overall**	**1,392.4**
Based on: N HEIs	**216**	**Based on: N HEIs**	**150**	**Based on: N HEIs**	**92**	**Based on: N HEIs**	**96**	**Based on: N HEIs**	**127**

[1] Including university-wide awards in the 3rd funding line of the Excellence Initiative (Institutional Strategies) and infrastructure funding.
[2] Not including awards within Institutional Strategies and infrastructure funding.
[3] Please see Tables Web-7, Web-8, Web-9, Web-10 and Web-11 at www.dfg.de/fundingatlas for data on other higher education institutions.

Note: Corresponds to Tabelle 3-3 of the DFG Förderatlas 2018.

Data basis and source:
Deutsche Forschungsgemeinschaft (DFG, German Research Foundation): DFG awards for 2014 to 2016.
Calculations by the DFG.

of the strength of the leadership positions. In the 2006, 2009 and 2015 editions, **LMU Munich**, **TH Aachen** and **U Heidelberg** led the ranking. Now, for the first time, clear differences can be seen within this top three. The DFG funding volume at **LMU Munich**, at €315.8 million, is €23.6 million higher than that of **U Heidelberg**, which in turn obtained €11.2 million more than **TH Aachen**, the institution which led the ranking in 1996, 2002 and 2008.

As in previous editions, the statistical indicator used to compare the rankings in the Funding Atlas, the rank correlation coefficient[2], is very high and currently stands at (comparing 2018 to 2015) Spearman's R = 0.95 (in contrast to 0.97 in a comparison of the rankings in the 2012 and 2015 Funding Atlases). The rankings for the four scientific disciplines, as shown in Table 3-3 for the current reporting period, are also highly stable. The correlations with the corresponding rankings in 2015 lie within the very narrow range of Spearman's R = 0.94 to 0.98, only just below the maximum possible value of 1.0, which would apply if two compared rankings had an absolutely identical ranking order.

DFG Rankings of Universities Comparing Scientific Disciplines

The university rankings comparing scientific disciplines have therefore remained very stable over time. Much lower correlations are observed if the rankings between scientific disciplines are compared (for the same points in time). For example, the ranking for the life sciences shown in Table 3-3 correlates with that for the natural sciences with Spearman's R = 0.33, while the rankings for the humanities and social sciences and the engineering sciences actually have a clear negative correlation (R = -0.45). In the engineering sciences, **TH Aachen** leads the ranking by a clear distance (at €134.3 million, the funding volume obtained is €47.9 million higher than that of the second-placed **U Erlangen-Nürnberg**) and at 10th place it also belongs to the leading institutions in the natural sciences. In the life sciences, it achieves a notable 29th place, and finally in the humanities and social sciences it ranks 45th.

This example illustrates how important it is to consider the subject orientation of an institution when examining rankings. As demonstrated in the Funding Atlas 2015, professors in mechanical engineering at universities obtained a higher DFG funding volume per capita, by a factor of 9 to 11, than those in humanities and social sciences subjects (DFG 2015a: 99ff.). In the updated analysis, this value increases to a factor of 9 to 16, here in a comparison between the humanities and social sciences subjects on the one hand and materials science and materials engineering on the other (see Table Web-34 at www.dfg.de/fundingatlas). However, this difference applies not only to DFG funding but also in a similar fashion to overall third-party funding revenues (see Table Web-33 at www.dfg.de/fundingatlas).

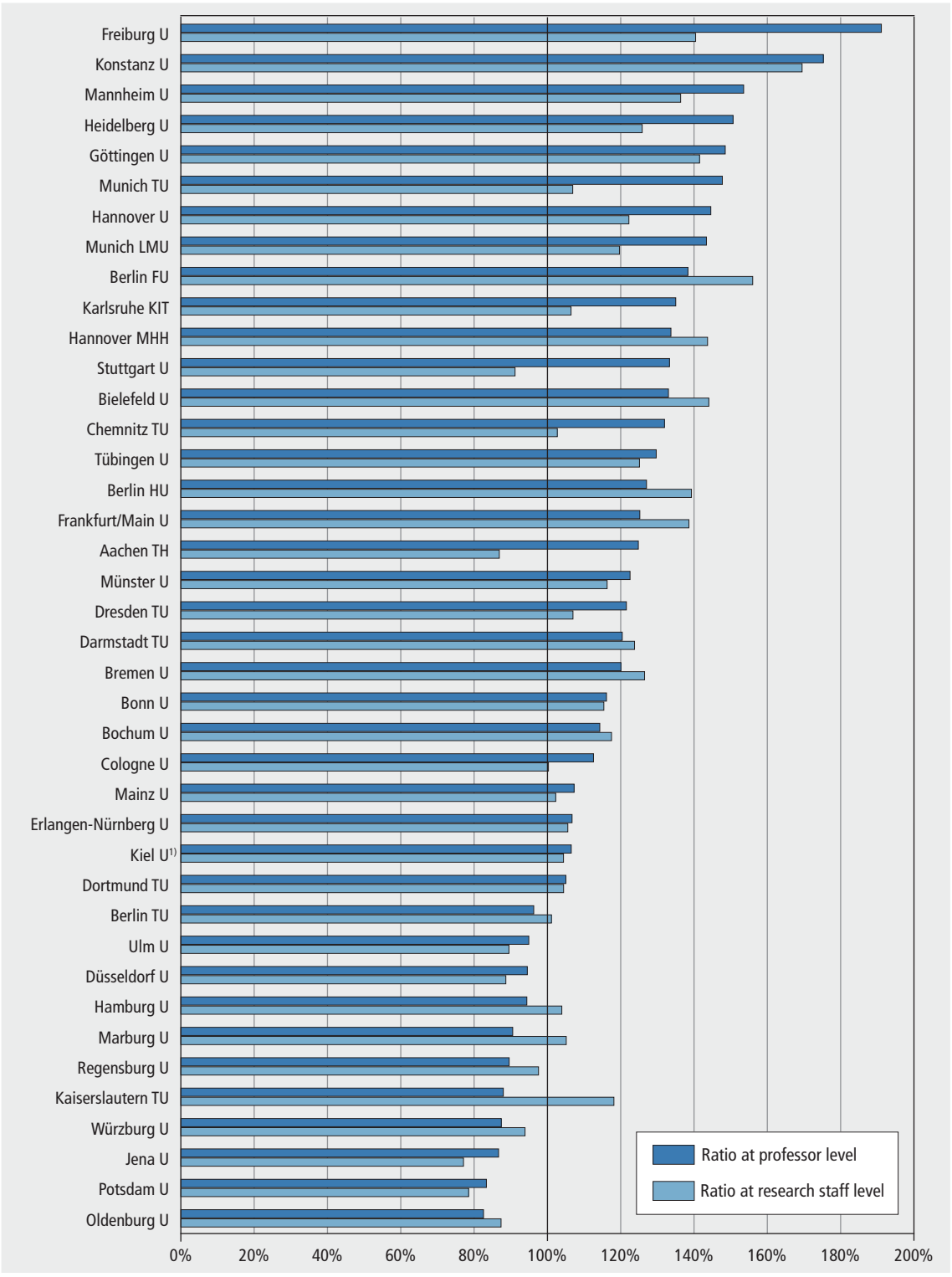
Only a small number of universities have therefore achieved leading places in more than two scientific disciplines. These few exceptions, **LMU Munich**, **U Heidelberg** and **TU Munich**, can be seen in Table 3-3. In all other cases, particular universities stand out in each discipline. In the humanities and social sciences, the leading institutions are **FU Berlin** and **HU Berlin**, with the relatively small **U Konstanz** also making it into the top 10. In the life sciences, **U Freiburg** occupies third place, in the natural sciences it is **U Bonn** (which also achieves 9th place in the life sciences) and in the engineering sciences second place goes to **U Erlangen-Nürnberg**.

DFG Awards to Universities in Relative Terms

In the Funding Atlas 2012, a new method was introduced to avoid the statistical effect caused by the different subject profiles of research institutions on the calculation of the indicators used. The aim of the calculation was to compare the actual proportion of women on the academic staff of a university with the expected proportion for the university in question given its subject profile and the typical average values for these subject areas for Germany as a whole. Using this method, it was possible to convert the normally lower numbers of women at technical universities, for example, such as to even out the influence of the ‚technical bias', making real comparisons possible (DFG, 2012: 93ff.). In the Funding Atlas 2015 the same method was used to calculate how much the third-par-

2 See also "Correlation coefficient" in the Glossary of Methodological Terms at www.dfg.de/fundingatlas.

Figure 3-3:
Ratio of DFG awards for 2014 to 2016 to statistically expected values by higher education institution



[1] Including the University Medical Center Schleswig-Holstein.

The 40 universities with the highest ratio of DFG awards to expected award volume in relation to the number of professors, corrected for subject structure and staff size, are shown. For further information on the underlying methodology, please see "Third-party funding corrected for subject structure" in the Glossary of Methodological Terms at www.dfg.de/fundingatlas.

Note: Corresponds to Abbildung 3-4 of the DFG Förderatlas 2018.

Data basis and sources:
Deutsche Forschungsgemeinschaft (DFG, German Research Foundation): DFG awards for 2014 to 2016.
Federal Statistical Office (DESTATIS): Education and Culture. Personnel at Higher Education Institutions 2015. Special analysis of Subject-Matter Series 11, Series 4.4.
Calculations by the DFG.

ty funding obtained by a university from the DFG lay below, above or approximately at the statistically averaged level that would be expected given the range of subject areas at the institution and the staff based there (DFG, 2015a: 64).

In Figure 3-3, this calculation is updated.[3] The ranking of 40 universities is arranged in descending order by the ratio of actual to statistically expected value at professor level. In the Funding Atlas 2015 this calculation was applied only to the 40 universities with the highest DFG funding volume in absolute terms, but in the present analysis the scope has been expanded. All universities which received more than €2 million from the DFG in the three-year period from 2014 to 2016 are now included in the calculation. This expansion of the method has resulted in the inclusion of two smaller but highly specialised institutions: **U Mannheim** now appears in 3rd place (in absolute terms: 52nd place) and **TU Chemnitz** in 14th place (in absolute terms: 42nd place). The first is a university with a clear focus on social and economic sciences, while the second is a smaller technical university with subject areas that also attract a lot of funding in the social sciences.

The focus on statistically expected values offers a perspective on universities' third-party funding acquisition that differs from the absolute figures. The rank correlation coefficient of R = 0.55[4] still indicates a clear correlation, which can also be seen by the fact that many universities still occupy leading places in both the absolute and the relative rankings (of the top 10 in the absolute ranking, six universities are still in the lead in Figure 3-3). However, the examination now allows room for the smaller and more specialised institutions mentioned above. For example, **U Konstanz** stands out in second place, having swapped places with the now leading **U Freiburg** in comparison with the Funding Atlas 2015, and occupies 23rd place in the absolute view. It should be noted that this prominent placing cannot be considered an effect of the university's successfully proposed Institutional Strategy. This funding line, part of the Excellence Initiative, is not tied to any particular subject area, and thus it is not included in the calculation adjusted for subject structure as described above.

3.3 50 Years of Collaborative Research Centres

Today, Collaborative Research Centres (CRC) are among the most important and prominent types of research group in the German research landscape. From the beginning, this funding instrument has been administered by the DFG. However, the initiative to set up the first CRC in 1968 originated with the German Council of Science and Humanities, with the following objectives. Firstly, the aim was to enable the concentration of staff, funding and facilities at universities by supporting high-performing research groups there. Secondly, the instrument was intended to create an incentive to intensify scientific cooperation. Thirdly, it was to promote division of labour between universities, allowing individual universities or faculties to concentrate on specific research areas. In this way, a system of group-based research was to be established covering the whole spectrum of the sciences and humanities (German Council of Science and Humanities, 1967: 128ff.). Over the next 50 years, these original goals were regularly adapted in line with current developments. For example, the goal of covering the full spectrum of the sciences and humanities at national level did not prove feasible, so this ceased to be an aim in 1977 (German Council of Science and Humanities, 1978: 73).

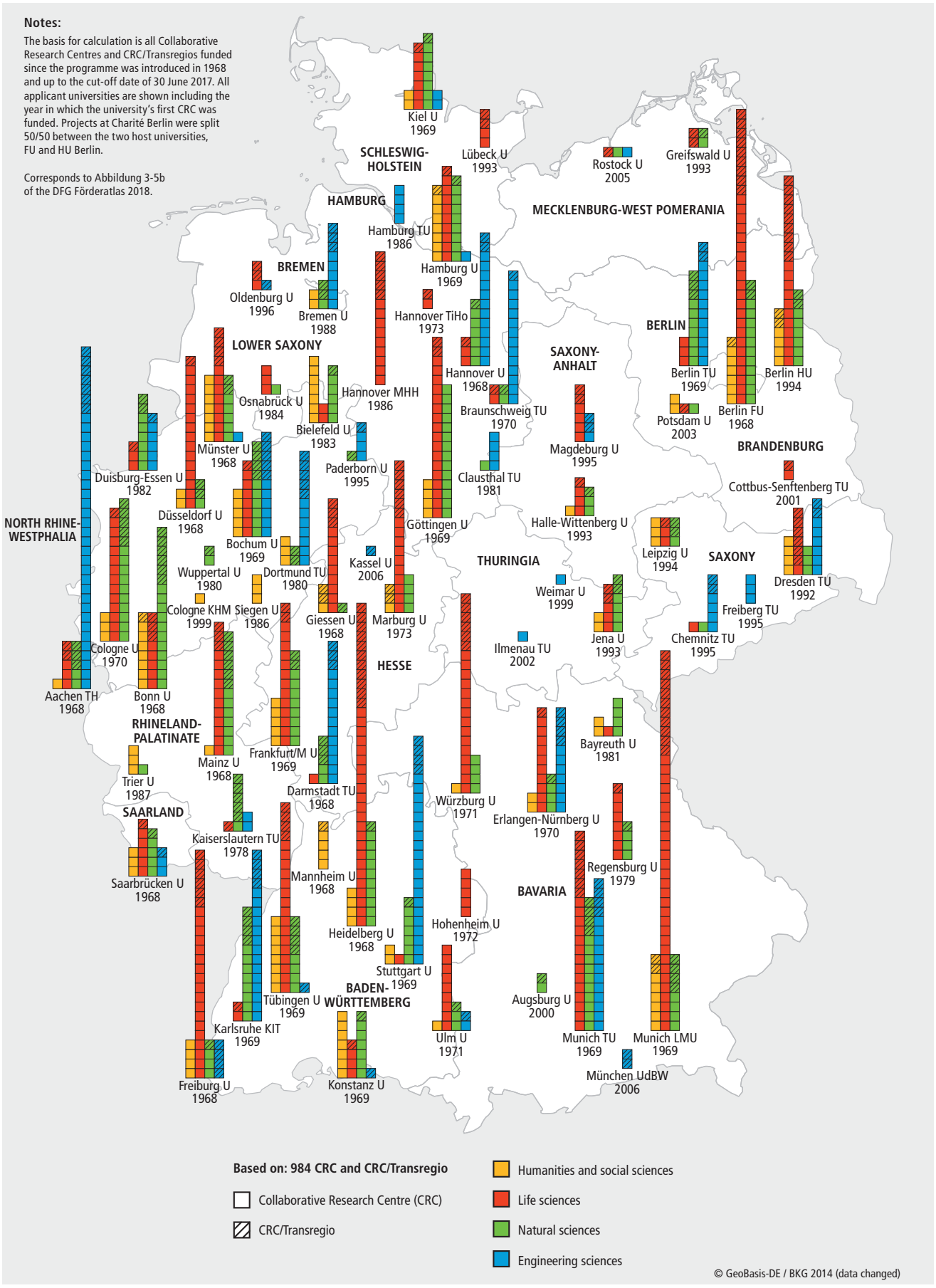
As at 30 June 2017, the Grants Committee for Collaborative Research Centres appointed by the DFG had approved over 984 proposals to set up a CRC. This number includes 109 CRC/Transregio. On this date, 69 German universities had submitted successful proposals (see Figure 3-4). In the past ten years alone, CRC have received more than €5 billion in funding; in the current reporting period of the DFG Funding Atlas they account for almost 23% of the DFG funding volume. The highest demand for this funding instrument is in the life sciences, which with 389 CRC make up over a third of all CRC funded to date and which regularly account for the primary focus of the majority of proposals.

In second place are the natural sciences with 253 CRC, followed by the engineering

3 See also „Third-party funding corrected for subject structure" in the Glossary of Methodological Terms at www.dfg.de/fundingatlas.

4 In relation to the value calculated for professors. In relation to all research staff, the rank correlation is R = 0.71. See also "Correlation coefficient" in the Glossary of Methodological Terms at www.dfg.de/fundingatlas.

Figure 3-4:
50 years of Collaborative Research Centres: number of groups by applicant university and scientific discipline



sciences with 216. Finally, 126 CRC with a focus on the humanities and social sciences have been approved to date (see Figure 3-4). According to the figures mentioned, the proportions represented by the four scientific disciplines over time therefore correspond approximately, with deviations of between 3 (humanities and social sciences) and 6 percentage points (life sciences), to the proportions characteristic of overall DFG funding activities in the current period (see Table 4-2).

One particular strength of this funding instrument is the interdisciplinary cooperation that for CRC tends to be the rule rather than the exception. Another characteristic is the high flexibility with which the approved funds can be used: each CRC can decide for itself how to react to developments and also develop the dynamism that makes it possible to conduct internationally competitive research at the highest level.

Figure 3-4 illustrates the extent to which Collaborative Research Centres shape the subject-based research profiles of German universities. For instance, technical universities such as **TH Aachen**, **TU Braunschweig** and **TU Chemnitz** successfully proposed a large number of CRC in the engineering sciences.

However, none of these universities has established a CRC in the humanities and social sciences. By contrast, there are universities with CRC exclusively in humanities and social sciences subjects, for example **U Siegen** and **U Mannheim**. At some universities, Collaborative Research Centres have significantly contributed to the development of whole research areas, including core research areas. This applies, for example, to astrophysics at **U Cologne**, where the first CRC focusing on this subject area was set up in 1990. This was followed almost seamlessly by further projects in 1999 and 2009, which were naturally able to benefit from the results and structures established by the original group.

The growing specialisation which can be observed in many disciplines can also be illustrated by means of Collaborative Research Centres. At the end of the 1960s, such groups typically bore the names of complete research areas, such as Oriental Studies, Theoretical Mathematics, Biochemistry or Cardiology. But by the early 1990s, to take the example of the field of cardiology, there were CRC investigating topics such as Heart function and its regulation and Pathophysiology of cardiac insufficiency. Finally, between 2006 and 2017 there was a CRC whose title revealed even greater specialisation within this field: Mechanisms and Imaging of Cell-Cell Interactions in the Cardiovascular System.

In addition to scientific cooperation within research areas at applicant universities, Collaborative Research Centres promote cooperation within the research system through collaboration between the different research institutions participating in a group. This can be seen in Figure 3-5, which shows a cartographic view of CRC funded between 2014 and 2016. The illustration shows in the form of a network diagram[5] how, firstly, CRC tend to bring together local resources, and secondly, how strongly transregional cooperation can also contribute to successful collaboration. The importance of CRC can also be seen from the following numbers, on which the illustration is based. A good two thirds of all CRC take advantage of the option of integrating projects at a participating university which is not an applicant institution. A good two thirds of the CRC in the three-year period mentioned above also include non-university-based projects.

Collaborative Research Centres also provide particular scope for cross-disciplinary cooperation. As documented in a special analysis of cross-disciplinary cooperation in DFG-funded groups in the DFG Funding Atlas 2015, Collaborative Research Centres in particular often bring together a very diverse range of disciplines (DFG, 2015a: 165). A study published in 2017 reveals that this is especially true of CRC in the humanities and social sciences, and that here, involvement in Collaborative Research Centres is particularly attractive to scholars in the so-called minor disciplines. While generally just under 40% of all CRC include researchers from minor disciplines, in the humanities and social sciences this figure increases to a good three quarters (DFG, 2017b: 25ff.).

Another aim of Collaborative Research Centres that has been increasingly emphasised over time is the aspect of internationalisation. As at 30 June 2017, around 15% of all funded CRC featured some special form of the international networking inherent to all CRC, for example through institutional cooperation with a research centre in another country, the implementation of one or more

5 See also "Cartographic network analyses" in the Glossary of Methodological Terms at www.dfg.de/fundingatlas.

Figure 3-5:
Participations by research institutions in Collaborative Research Centres and CRC/Transregio and resulting collaborative relationships 2014 to 2016

projects abroad, or regular research trips to areas of investigation outside Germany. Many more groups integrate visiting researchers from abroad who can receive funding for a research visit of up to two years through the Mercator Fellow module. Collaborative Research Centres also offer an attractive working environment for researchers who have worked abroad. For example, around 15% of all doctoral researchers in Collaborative Research Centres were previously based at a university or research institution abroad, with the figure for postdoctoral researchers being higher at almost 24% (see chapter 5).

Collaborative Research Centres have been in existence for 50 years, but the programme is as important and relevant as ever – as was emphasised on the 40th anniversary by the German Council of Science and Humanities. In a statement on Collaborative Research Centres and DFG Research Centres published in 2009, it said: „The CRC programme has set the standard for other approaches to the funding of research groups, not least the Excellence Initiative." (German Council of Science and Humanities, 2009: 33). The connection can also be seen in the fact that the vast majority of Clusters of Excellence established within the Excellence Initiative or for which proposals were invited as part of the Excellence Strategy in 2017 clearly build on previous work by one or more CRC established at a given location. In contrast to Collaborative Research Centres, which are organised into individual projects, Clusters of Excellence provide a more open, flexible framework for extensive, long-term coordinated research, enhancing the portfolio of funding instruments for group research. The opportunity provided by Collaborative Research Centres of creating high-performing groups that strengthen a university's profile and have a structuring effect will continue to play an important role.

3.4 Germany as a Polycentric Research Nation

As shown at the beginning of chapter 3 by means of a location map of German research institutions, the research landscape in Germany has numerous centres of activity distributed across the country (see Figure 3-1). The idea that collaboration between institutions and disciplines in a single location gives essential impetus to innovative research was popularised by the highly successful phenomenon of Silicon Valley, in the southern part of the San Francisco Bay Area. Even in an age of teleconferencing and worldwide communication via social networking sites for academics such as Academia.edu and ResearchGate, the ease with which ideas can be shared locally is often an important prerequisite for successful research.

Since the second edition of the DFG Funding Atlas in 2000 – which focused solely on DFG funding (DFG, 2000: 113ff) – special attention has been given to the topic of regions. Since then, the presentation of figures by region in the Funding Atlas has been steadily expanded and the range of methods used has been continually developed. 2015 saw the introduction of the analytical level of spatial development regions (ROR), adapting to a standard developed by the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR) (DFG, 2015a: 70f.). This system distinguishes 96 regions which (with the exception of city-states) comprise large-scale, functionally separate spatial units. The names used in the Funding Atlas for ROR correspond to the nomenclature developed by the BBSR.[6]

To analyse its funding activity by region, since 2005 the DFG has been using a database that allows every funded project to be classified on the basis of its institutional origin. The system is structured such that each institute, chair or other organisational unit of a university or non-university research institution is localised precisely using its spatial coordinates. The database therefore provides the basic framework for the institutional and cartographic organisation of the data contributed by other funding providers for the DFG Funding Atlas.[7] The online database GERiT – German Research Institutions (www.gerit.org) and the DFG project information system GEPRIS (www.dfg.de/gepris) also benefit from it. They allow the underlying data to be searched using a location-based search and, in the individual view in GEPRIS, show the exact location of an institute in map format, similar to the route planning in navigation systems. In its recommendations on the Research Core Data Set, the German

6 See also "Regions" in the Glossary of Methodological Terms at www.dfg.de/fundingatlas.

7 See also "DFG institutions database" in the Glossary of Methodological Terms at www.dfg.de/fundingatlas.

Council of Science and Humanities therefore recommends the DFG institutions database as the standard for the subject-based indexing of research activities at research institutions in Germany (German Council of Science and Humanities, 2016: 82).

Interactive Maps in DFG Funding Atlas Online Content

As a new feature, the online material accompanying the DFG Funding Atlas 2018 at www.dfg.de/fundingatlas also includes all the maps printed here in an interactive format. For each federal state and region, the award amounts per subject area, funding area and funding provider can be selected and viewed together, as the user prefers, for each provider. The ability to select individual subject and funding areas makes it easier to compare the profiles of different regions. The most important universities and non-university research institutions in the regions are still shown and linked to the relevant entries in the DFG Funding Atlas online content or the DFG project database GEPRIS. In GEPRIS, the user can then search for DFG projects at a given institution.

Research Profiles of DFG Funding

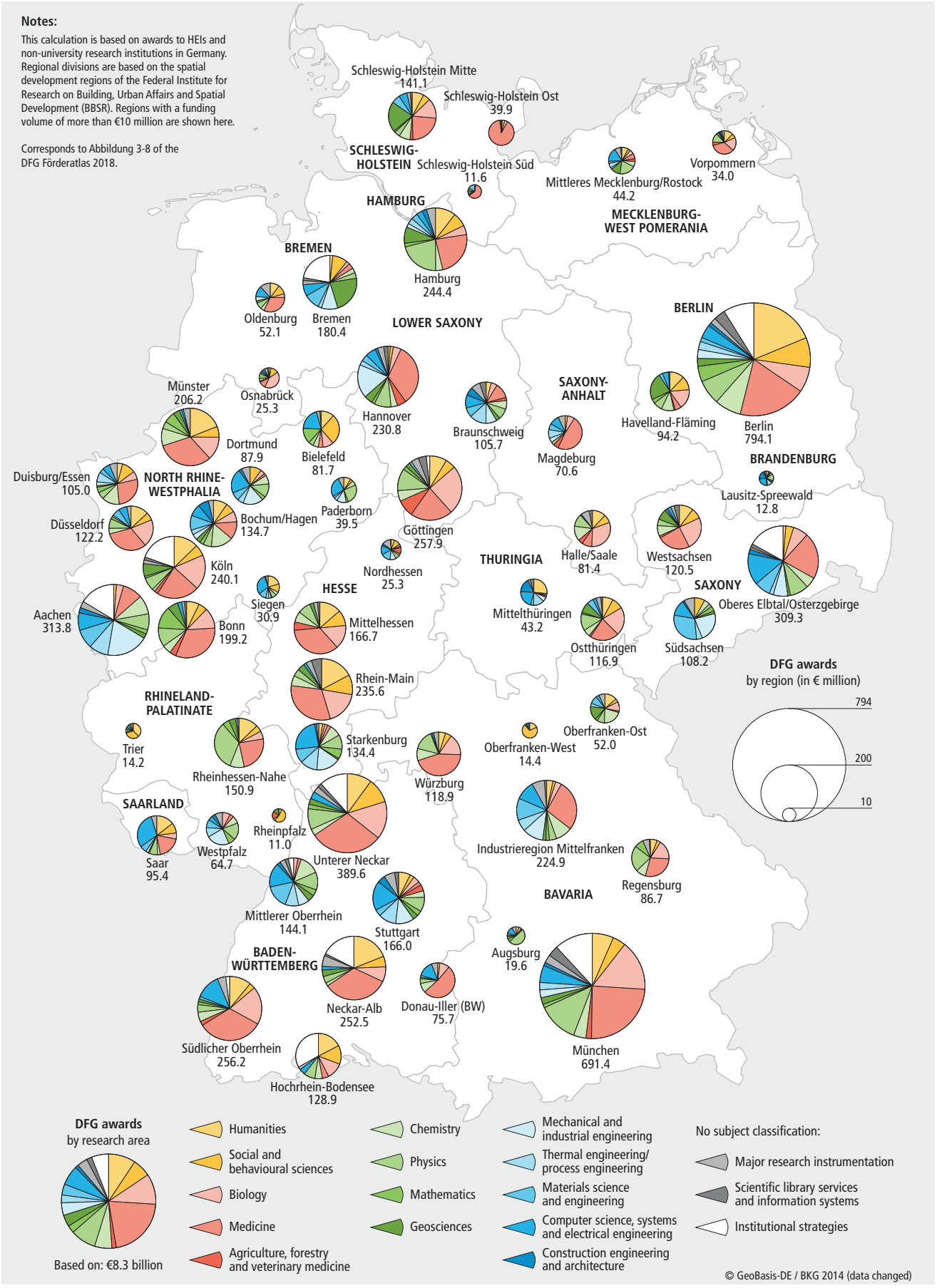
Typically, in DFG funding, the regional view is primarily a view of the universities situated in a given region. As shown in Table 3-1 in section 3.1, the majority of DFG awards go to researchers based at higher education institutions. Figure 3-6 shows the regional distribution broken down into the 14 research areas defined in the DFG subject classification system. The distribution also takes account of funding instruments not included in the classification system: Major Research Instrumentation, Scientific Library Services and Information Systems, and Institutional Strategies within the Excellence Initiative. In total, the diagram comprises data on projects with a volume of around €8.3 billion for the period 2014 to 2016.

Berlin and München immediately stand out as regions that attract a particularly large amount of DFG funding. As already indicated, this is primarily due to the fact that these are two of the few regions, another example being Hannover, that have multiple large universities and other higher education institutions (see Figure 3-1). In the current reporting period, Berlin accounts for the largest volume of DFG funding by some distance. The total amount for 2014 to 2016 is a good €100 million higher than that for München. In the reporting period 2011 to 2013 (DFG, 2015a: 74), the difference was around €80 million. Other regions very active in DFG funding programmes are Unterer Neckar (Heidelberg and Mannheim), Oberes Elbtal/Osterzgebirge (around Dresden), Südlicher Oberrhein (centred around Freiburg), Aachen and Göttingen, with amounts ranging from €250 million to just under €400 million.

In the DFG classification system, the three research areas of Biology, Medicine, and Agriculture, Forestry and Veterinary Medicine together form the discipline of life sciences (shown in different shades of red in the diagram, see also Table 4-1). At exactly one third, this discipline accounts for the largest proportion of DFG funding volume in the period under consideration (see also Table 4-2). As the map shows, the regions of Donau-Iller (Baden-Württemberg), Würzburg, Magdeburg, Vorpommern, Göttingen, Südlicher Oberrhein, Mittelhessen, Osnabrück and Düsseldorf are also strong in the life sciences, usually with a focus on medical research. The East and South regions of Schleswig-Holstein, home to the Schleswig-Holstein University Hospital operated jointly by the universities of Kiel and Lübeck, are also strongly characterised by medical research.

In both absolute and relative terms, Berlin is a strong location for humanities and social sciences research in its DFG profile. The more than €214 million awarded in both research areas corresponds to 27% of the total volume of DFG funding received by Berlin in the reporting period. Similarly high proportions are recorded for the regions of Rhein-Main, Hochrhein-Bodensee, Siegen and Bielefeld. In the Oberfranken-West region, where **U Bamberg** is located, more than 86% of DFG third-party funding is awarded to projects in the humanities and social sciences – a prominent example being GSC 1024 *"Bamberg Graduate School of Social Sciences (BAGSS)"*, which has been funded as part of the Excellence Initiative since 2012. Trier and Rhein-pfalz also have proportions of 60% or more in the humanities and social sciences.

Figure 3-6:
Regional distribution of DFG awards for 2014 to 2016 by research area



Research Profiles of Direct Federal Government Funding for R&D Projects

Figure 3-7 shows which regions are especially active in the acquisition of direct federal funding for R&D projects. The diagram is based on projects funded between 2014 and 2016 with a total volume of €10.5 billion. This view considers by region the funding recipients that attracted third-party funding through direct federal support for R&D. Unlike the DFG, which mainly awards funding to universities and, to a limited extent, non-university research institutions, a large proportion of federal R&D funding, almost 33%, goes to projects in industry (see Table 3-1).[8]

A glance at the regions which attract the most funding reveals that, as with DFG funding, the Berlin and München regions stand out prominently. With close to €900 million in third-party funding from direct federal project funding, Berlin once again takes the top position. Researchers in München attracted €770 million. Another very active region is the Oberes Elbtal/Osterzgebirge around Dresden. High funding volumes can also be seen for locations which are home to major technical universities in the Aachen region and in Stuttgart. In terms of federal funding, Hamburg, with the fourth highest volume for federally funded projects in the regional comparison, accounts for a large proportion of the resources allocated to the Helmholtz Association. As shown in the last Funding Atlas, this is primarily due to the construction of the **European X-Ray Free-Electron Laser Facility (European XFEL)** at the **Deutsches Elektronen-Synchrotron (DESY)**. Other institutes of the Helmholtz Association have attracted large volumes of direct federal project funding, mainly in Braunschweig, Havelland-Fläming (with the **German Research Centre for Geosciences (GFZ)** in Potsdam) and Aachen.

In terms of the proportion of commercial research in the regions, München, Stuttgart, Südsachsen, Düsseldorf and Rhein-Main are especially prominent. The Industrieregion Mittelfranken, which emphasises its profile in its name, is also particularly characterised by industry-driven research supported by federal funding, as are the Heilbronn-Franken region and some other small locations in the southern part of Baden-Württemberg and Bavaria.

The region of Südlicher Oberrhein has a striking profile, with nearly half of federal funding being awarded to projects of the Fraunhofer-Gesellschaft (FhG); special mention should be made for example of the **Fraunhofer Institute for Solar Energy Systems (ISE)**. The FhG also accounts for a large proportion of regionally acquired third-party funding volume in the Oberes Elbtal/Osterzgebirge (centred around Dresden), with ten federally funded Fraunhofer institutes, and in Bremerhaven, with the **Fraunhofer Institute for Wind Energy Systems (IWES), Northwest section.**

Research Profiles of EU Funding in the EU Framework Programme Horizon 2020

The overview of regional profiles concludes with a look at the funding obtained through Horizon 2020 in Figure 3-8. The cartographic view shown here is based on data on projects with a total volume of €3.9 billion over three funding years (2014 to 2016).[9] The categorisation into programmes can be seen in Table Web-41 at www.dfg.de/fundingatlas. The 12 largest programmes are shown individually and all other programmes are shown together in a single category.

With regard to funding obtained in the EU Framework Programme Horizon 2020, München and Berlin are once again in the lead with the largest funding volumes by some distance. However, in this case the higher amount actually went to München (€465 million compared with €309 million for Berlin). The Stuttgart, Aachen, Unterer Neckar (Heidelberg/Mannheim) and Oberes Elbtal/Osterzgebirge regions are also very successful in the EU Framework Programme. In the overall view of all three funding providers covered here, the region centred around Dresden therefore emerges as one of the leading research locations in Germany. The region of Vorpommern occupies a special position in this comparison, having attracted

8 A similar situation applies with regard to EU funding, for which a corresponding cartographic view was presented in the DFG Funding Atlas 2015 (DFG, 2015a: 83).

9 In comparison to the data published in the DFG Funding Atlas 2015, it should be noted that the data there related to the full seven-year period of the 7th Framework Programme (2007 to 2013; DFG, 2015a: 81ff.).

Figure 3-7:
Regional distribution of direct R&D funding from the federal government 2014 to 2016 by type of funding recipient

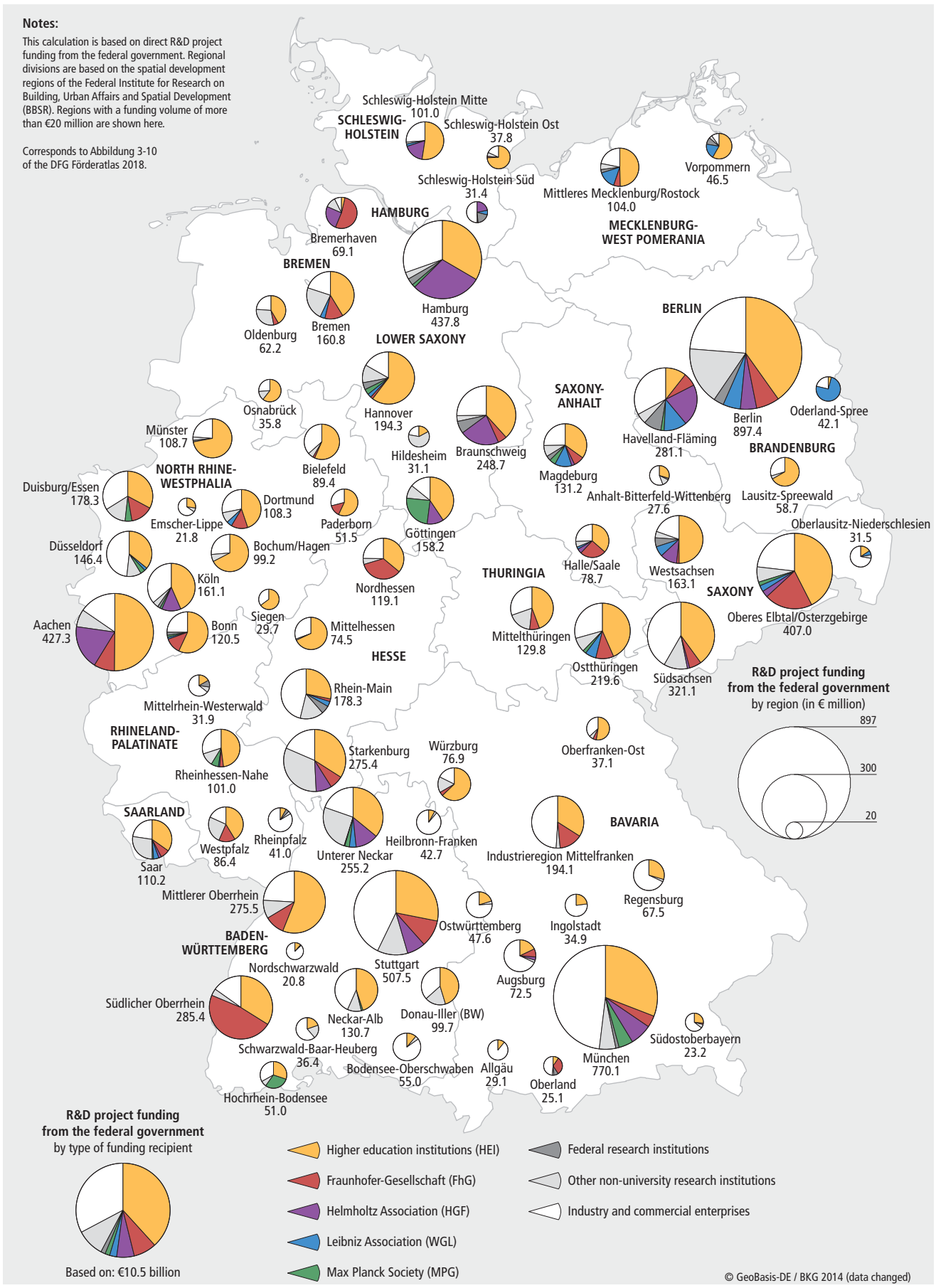
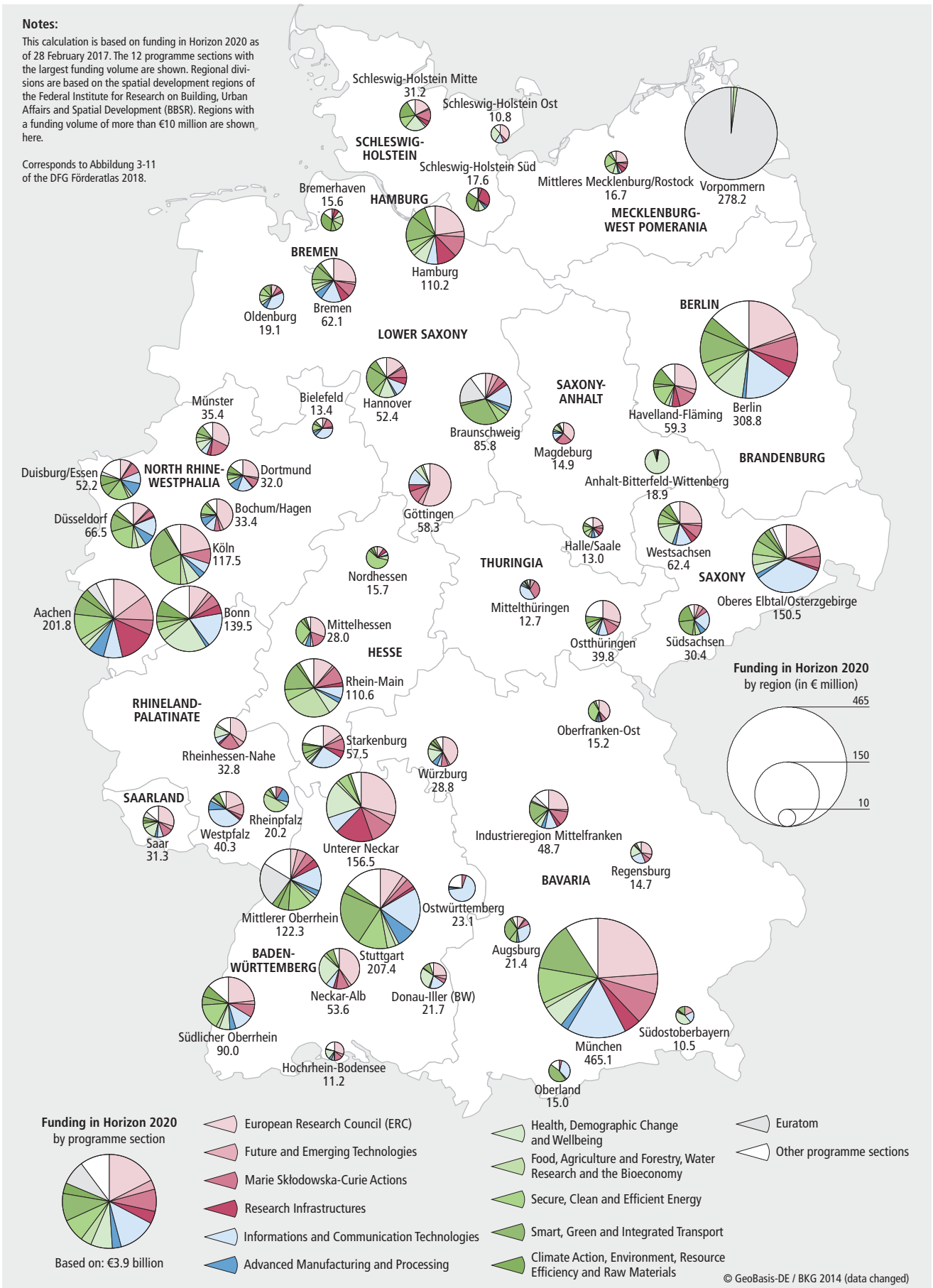


Figure 3-8:
Regional distribution of funding in Horizon 2020 – EU Framework Programme for Research and Innovation 2014 to 2016 by programme section



more than €270 million in the EU's Euratom programme during the reporting period. A large proportion of this funding went towards the construction and operation of the **Wendelstein 7-X Fusion Reactor** in Greifswald, which was completed in 2014.

As an addition to the data presented in the DFG Funding Atlas 2015, Figure 3-8 now also shows separately funding obtained from the European Research Council (ERC). This has the effect of revealing how successful the researchers in a given region were in attracting funding from a provider which is generally recognised for its strict selection criteria and strong focus on quality. The proportion of Horizon 2020 funding represented by ERC awards is around 18% for the whole of Germany. The regions of Göttingen, Würzburg and Bochum/Hagen lie significantly above this level. The first two locations have a clear focus on medical research; in Göttingen both the university and the Max Planck Institutes based there were successful in obtaining ERC funding. Other locations with considerably above-average ERC participation are Neckar-Alb (Tübingen) and Oberfranken-Ost (around Bayreuth). While these regions have high ERC funding in relative terms, the strongest regions in absolute terms are München, Berlin and Unterer Neckar.

A comparison of the current distribution with the regional profiles for EU funding in the DFG Funding Atlas 2015 reveals considerable similarities. There have been some minor changes, for example in München, where the proportion for information and communication technology projects has fallen slightly, with an increase in the energy sector. In Bonn, more EU-funded research is now being carried out in healthcare. Here too, funding amounts for information and communication technologies have fallen in relative terms. Generally speaking, both the EU profiles and the DFG and federal funding profiles show a high degree of long-term stability. The maps do not show moments in time, but document a picture of regional research and cooperation potential which is relatively stable over time.

3.5 Excellent Research in Germany – the Excellence Strategy

The aim of the Excellence Initiative, launched in 2005 with two phases, is to promote top-level research and make Germany an even better place to teach and research across the board. Between 2005 and 2017, the federal and state governments made approximately €4.6 billion available for funding purposes. The implementation of the Excellence Initiative is the joint responsibility of the DFG and the German Council of Science and Humanities.

In 2016, as a further development of the Excellence Initiative, the federal and state governments concluded an administrative agreement that established the Excellence Strategy (ExStra) (GWK, 2016). A key innovation of the Excellence Strategy is that it has no defined end point. For the period 2018 to 2027, more than €5.3 billion is available for the two funding lines of Clusters of Excellence and Universities of Excellence (DFG, 2017a: 9).

The Excellence Initiative in the Funding Atlas 2018

The statistical reporting in the previous and following sections includes the second phase of the Excellence Initiative, which was still ongoing in the reporting period. 45 Graduate Schools, 43 Clusters of Excellence and 11 Institutional Strategies were in receipt of funding. The Funding Atlas reports on a sum of approximately €1.6 billion awarded for the period 2014 to 2016.[10] The previous edition of the Funding Atlas included a special section focusing on detailed analysis of the Excellence Initiative, for example, an interdisciplinary profile of the Graduate Schools and Clusters of Excellence funding lines supervised by the DFG (DFG, 2015a: 85ff. and 163ff.).

Excellence Strategy of the Federal and State Governments

To complement this, this section focuses on the results of the Excellence Strategy and also examines the review process. The decisions

10 See also „Excellence Initiative" in the Glossary of Methodological Terms in the appendix.

were made on 27 September 2018 and 19 July 2019, after the publication of the German-language edition of the Funding Atlas. The findings detailed below therefore appear only in this English edition.

The main objective of the Excellence Strategy is to continue the successful impact of the Excellence Initiative and secure it in the long term. It is designed to strengthen German universities and thus Germany's position as an outstanding place of research and further enhance its international competitiveness. The long-term funding is intended to create long-term prospects for excellent research in Germany, and pursues separate goals through the two funding lines of Clusters of Excellence and Universities of Excellence.

The Clusters of Excellence funding line supports project-based, internationally competitive fields of research at universities or in university consortia. The federal and state governments are providing approximately €385 million per year for this funding line. This is essentially a continuation of the funding line established as part of the Excellence Initiative.

The Universities of Excellence funding line is designed to strengthen universities as institutions (individually or in a consortium with other universities) and further develop their leading international role on the basis of successful Clusters of Excellence. It builds on the Institutional Strategies funding line in the Excellence Initiative, with the significant difference of having a long-term perspective. Approximately €148 million per year is available for Universities of Excellence.

The Clusters of Excellence funding line will continue to be administered by the DFG. The development and implementation of the Universities of Excellence funding line is the responsibility of the German Council of Science and Humanities.[11] The Graduate Schools funding line, which forms the third pillar of the Excellence Initiative, is not being continued in the Excellence Strategy.

Decisions in the Universities of Excellence Funding Line

The decisions for the Universities of Excellence funding line were made on 19 July 2019 by the Committee of Experts for the Excellence Strategy. The chosen universities are shown in green in Figure 3-9.[12] The selection was made on the basis of 26 proposals submitted by 24 individual universities and two university consortia. A total of eleven universities will now receive long-term funding of up to €15 million. The successful applicants were **TH Aachen**, the consortium of the three Berlin universities **FU Berlin**, **HU Berlin** and **TU Berlin**, **U Bonn**, **TU Dresden**, **U Hamburg**, **U Heidelberg, KIT Karlsruhe, U Konstanz, LMU Munich, TU Munich** and **U Tübingen**. Of these selected institutions, **TU Aachen**, **FU Berlin**, **HU Berlin**, **TU Dresden**, **U Heidelberg**, **U Konstanz**, **LMU Munich**, **TU Munich** and **U Tübingen** were previously successful in the Institutional Strategies funding line of the Excellence Initiative.

As part of the Universities of Excellence funding line, these universities and consortia now have the opportunity to strengthen their international leading positions, visibility and networking within an overall programme of institutional development, provide ongoing support for early career researchers and encourage early independence, and recruit outstanding researchers from all over the world. For the first time in seven years, the German Council of Science and Humanities is evaluating the progress made. The results of this evaluation will provide the basis for deciding on the nature and scope of continued funding.

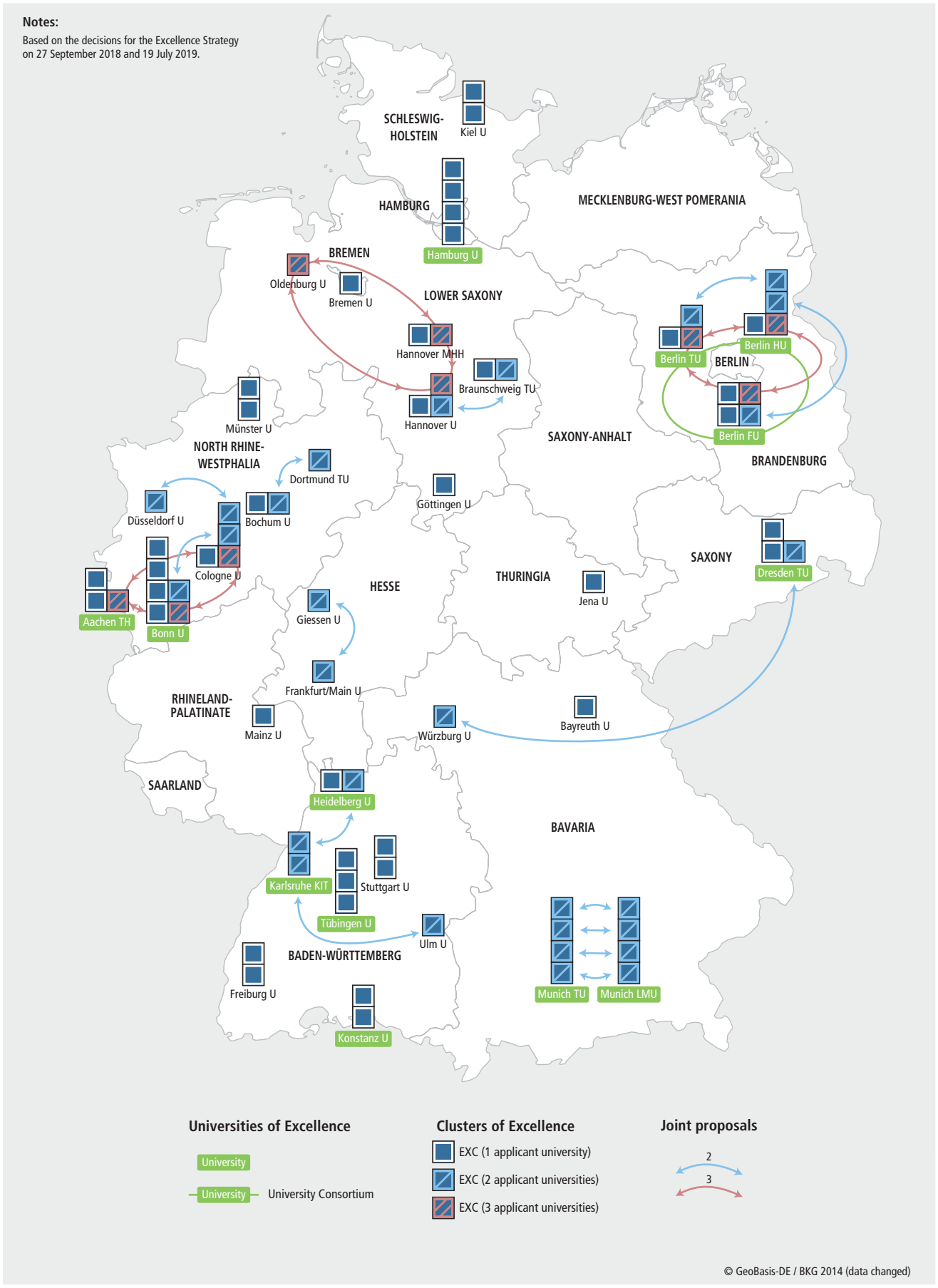
Decisions in the Clusters of Excellence Funding Line

Figure 3-9 shows the locations at which Clusters of Excellence are being funded. The blue squares (plain, crossed by single line or crossed by double line) indicate the group structure of the clusters. A total of 57 Clusters of Excellence were approved at 34 universities. 70% of the ExStra clusters are based at a single university, with another quarter being proposed by two universities and three Clusters of Excellence each linking three universities. The Munich-based universities **(LMU Munich** and **TU Munich)** show a particularly high level of cooperation, with all four clusters being based at both institutions. In Berlin there is also close cooperation between

11 www.wissenschaftsrat.de/en/fields-of-activity/excellence_strategy.html

12 Further information about the decision, plus an interactive map of the Universities of Excellence, can be found at www.dfg.de/sites/exu-karte/en.html.

Figure 3-9:
Universities of Excellence and Clusters of Excellence – locations and collaborative relationships



FU Berlin, **HU Berlin** and **TU Berlin**: in addition to a cluster supported by all three universities, the region has two bilateral clusters and four clusters supported by a single university. As well as Baden-Württemberg with 12 approved Clusters of Excellence, universities in North Rhine-Westphalia were particularly successful. With 14 Clusters of Excellence, including six at **U Bonn** alone, this federal state has a strong concentration on this Excellence Strategy funding line. An interactive map of current Clusters of Excellence is available on the DFG website at www.dfg.de/sites/exu-karte/en.html.

Broad International Review Process for Clusters of Excellence

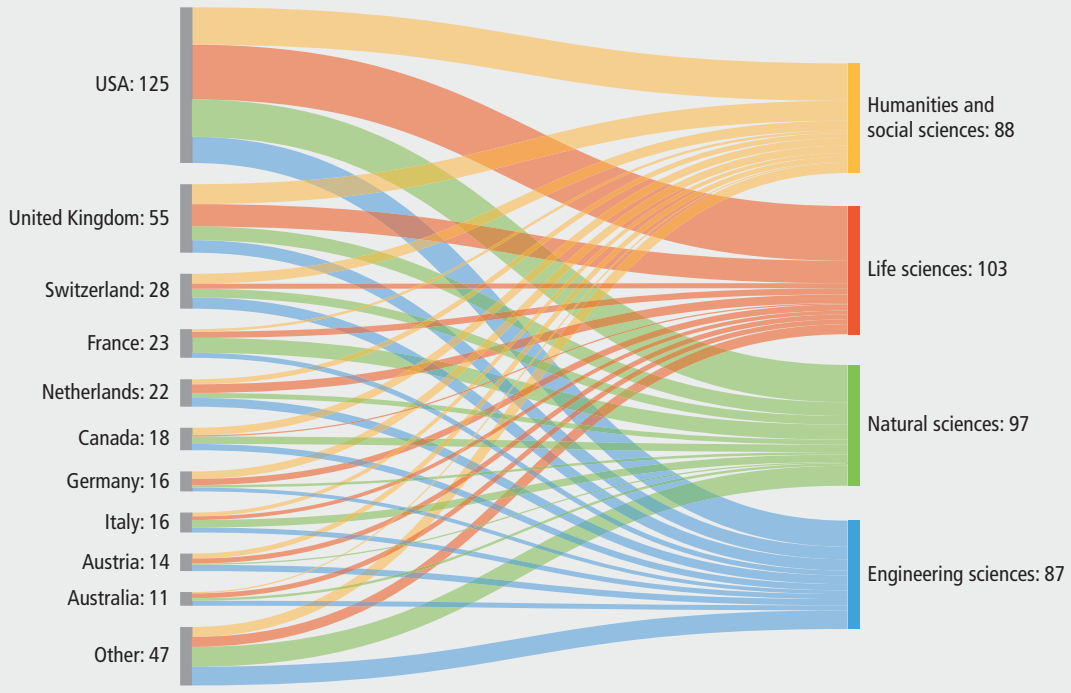
The decisions in the Clusters of Excellence funding line were supported by a large number of internationally respected reviewers. 195 draft proposals submitted by 63 institutions were first reviewed, and following evaluation by 255 mostly international reviewers in 21 specialist panels, 88 applicants were invited to submit a full proposal. Then, in September 2018, the final decision was made by the Excellence Commission[13] which approved 57 Clusters of Excellence as noted above. Figure 3-10 shows the countries of origin and disciplines of the reviewers for Clusters of Excellence. Over 55% came from English-speaking countries, including the USA, the UK, Canada and Australia.

Reviewers from high-performing smaller research nations, such as Switzerland and the Netherlands, were also well represented in the evaluation of Clusters of Excellence.

An examination of the individual disciplines shows that reviewers in the engineering sciences came from an especially diverse range of countries. While a large proportion of reviewers in the life sciences came from the USA, for the engineering sciences there is no such concentration on a single country. It should be emphasised that the decisions on

13 The Commission is international in its make-up, consisting of members of a Committee of Experts set up by the Joint Science Conference (GWK) (GWK 2019) and the ministers responsible for science and research in the federal and state governments.

Figure 3-10:
Number of reviewers for Clusters of Excellence by country of origin and scientific discipline



Data basis and source:
Deutsche Forschungsgemeinschaft (DFG, German Research Foundation): Reviewers for Clusters of Excellence.
Calculations by the DFG.

Clusters of Excellence in the humanities and social sciences were also prepared by a diverse international panel of experts. The 88 reviewers came from 16 countries, with the USA and the UK at the top of the list.

Additional detailed statistics on the funding decisions for Clusters of Excellence are available in the German-language publication *Exzellenzstrategie des Bundes und der Länder. Statistische Übersichten zu den Förderentscheidungen zu Exzellenzclustern* (DFG 2019). Available in the same area of the DFG website are the results of a survey of reviewers carried out in partnership with social research institute infas, which achieved a satisfyingly high resonance with a response rate of 72.5%. The report (available in German and English) provides important information about reviewers' opinions of the review procedure and the quality of the proposals submitted for evaluation. The survey results also reveal what kind of information was particularly important during the review process and the experience of the reviewers selected by the DFG (infas 2018).

Broad Institutional Participation

While Figure 3-9 shows the decision in the Clusters of Excellence funding line at the level of the applicant universities, Figure 3-11 shows the varied and extensive participation of other higher education institutions and non-university institutions in the Excellence Strategy clusters. Here, the analysis is based on the details of the home institutions of the principal investigators involved in the clusters, as stated in the funding proposals.[14]

In addition to the universities that form a clear focal point, as shown in Figure 3-11, it is possible to see an extensive, dense network of other institutions with a greater or lesser degree of participation, including higher education institutions, institutes of the Max Planck Society, the Leibniz Association, the Helmholtz Association and the Fraunhofer-Gesellschaft. A variety of other research institutions are also integrated in the cooperation networks of DFG-funded Clusters of Excellence, including non-university hospitals, academies of sciences and humanities, museums and collections.

14 See also "Cartographic network analyses" in the Glossary of Methodological Terms at www.dfg.de/fundingatlas.

Nationwide Networking of Research through the Excellence Strategy

As is so often the case, Berlin forms a clear regional hub for these participations. The location benefits from the large number of non-university research institutions situated there. The connecting lines shown in Figure 3-11 clearly indicate that these institutions not only interact within their own area but are also involved in Clusters of Excellence throughout Germany. Similar patterns of cooperation can be observed in other regions too, for example Hamburg. Research institutions in North Rhine-Westphalia which are involved in Clusters of Excellence are much more spatially distributed; **Forschungszentrum Jülich** and the **MPI für Kohlenforschung**, for example, are extensively involved in Clusters of Excellence. Other regions with significant participation in Clusters of Excellence can be seen in the areas around Munich, Stuttgart/Tübingen and Braunschweig/Hannover, the region around Jena and Dresden in the east and around Bremen in the northwest.

Subject-based Collaborations in Clusters of Excellence

35% of approved Clusters of Excellence are in the natural sciences, 26% in the life sciences, 21% in the engineering sciences and 18% in the humanities and social sciences (DFG 2019: 9).[15] If, in addition to these statistics focusing on the main discipline, we consider the subject diversity of the principal investigators involved in a cluster, the resulting picture clearly reveals how open these four disciplines are to cross-disciplinary cooperation. The subject area network represented in Figure 3-12 is based on data that provides information about the subject areas of the institutes[16] where the principal investigators work according to the funding proposal. The total of 1,396 individuals are divided among 968 institutions, which in turn can be classified into 232 different subject areas. The diagram

15 On the subject-area classification, see also "DFG classification system" in the Glossary of Methodological Terms at www.dfg.de/fundingatlas and section 4.1.

16 According to the classification of the Federal Statistical Office; see Table Web-32 at www.dfg.de/fundingatlas.

Figure 3-11:
Participations by research institutions in Clusters of Excellence in the Excellence Strategy of the federal and state governments and resulting collaborative relationships 2018

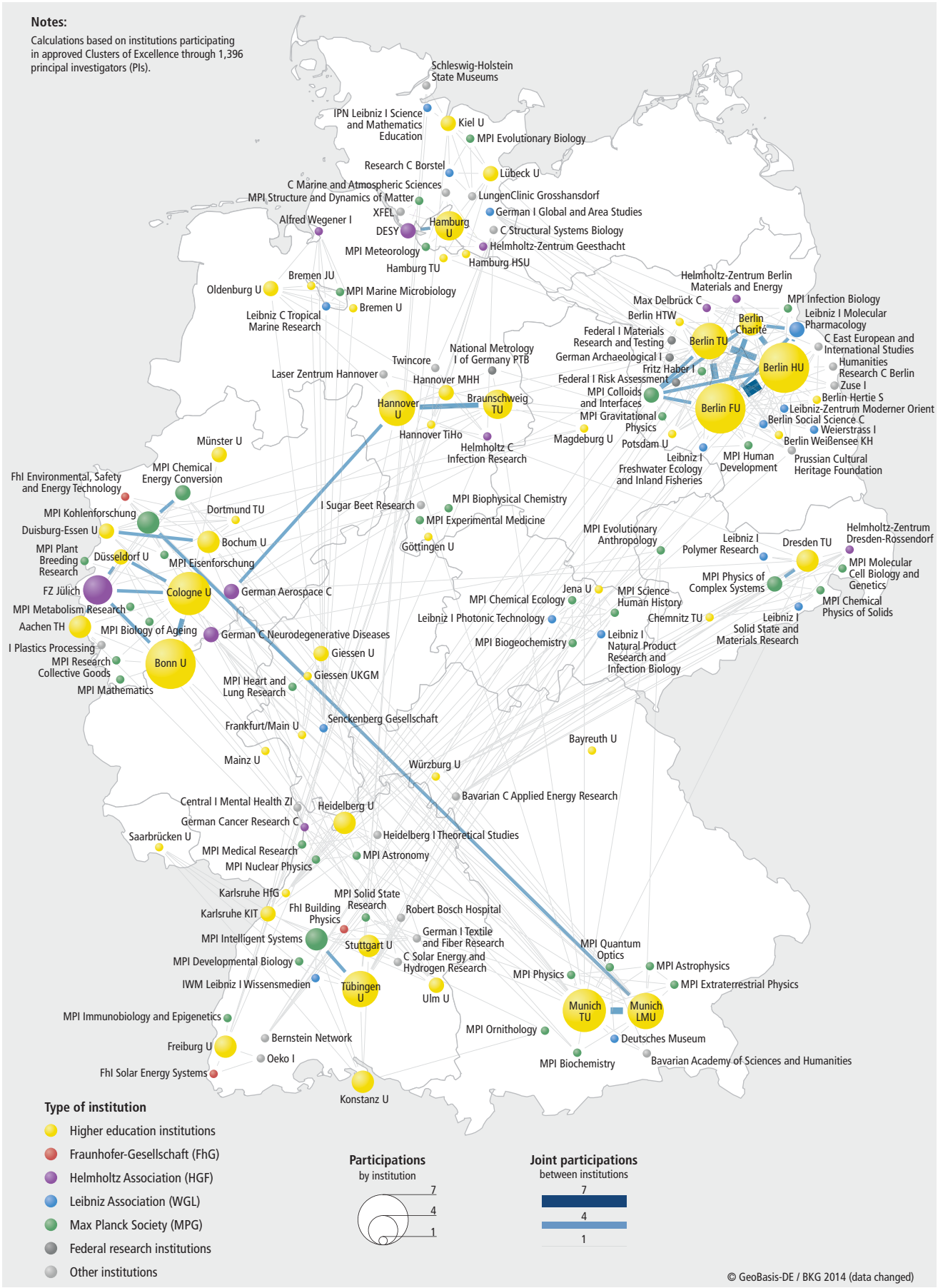
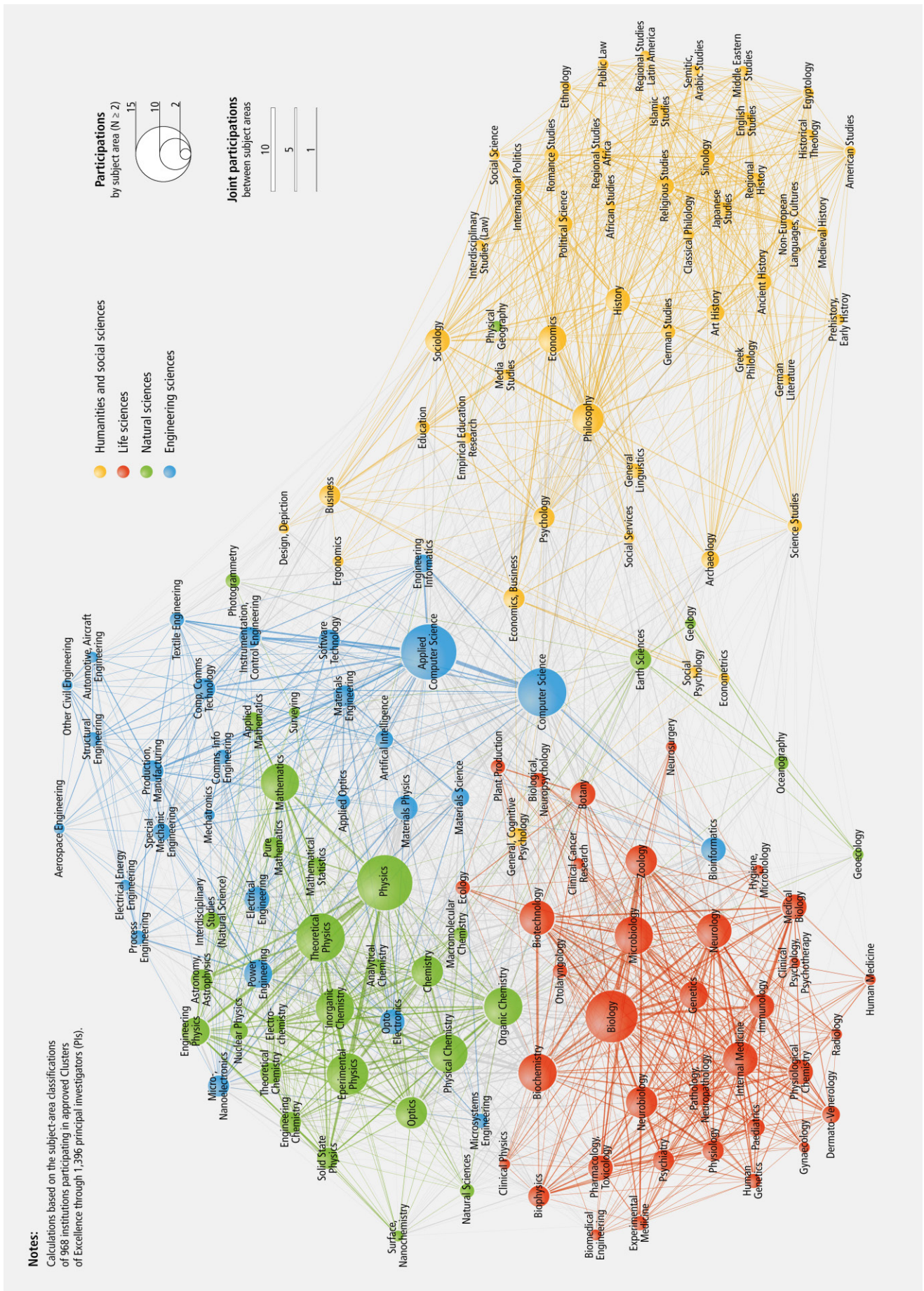


Figure 3-12:
Network of subject areas involved in Clusters of Excellence



shows the network formed by 143 of these subject areas with at least two participations, each link between two subject areas being defined by at least one shared cluster participation on the part of the correspondingly classified PI institutes. The more frequently institutes in a particular subject area are involved in shared Clusters of Excellence with other such subject areas, the thicker the line. The proximity of subject areas defined in this way is visually reinforced by the fact that groups of subject areas with frequent interaction are shown close to each other.

The figure confirms the strong links between the four scientific disciplines defined by the DFG. While the humanities and social sciences appear as a closely interwoven, yet relatively self-contained cluster of subject areas, the picture for the 'hard' sciences is more interconnected. Although clear discipline-focused areas of cross-disciplinary cooperation can be identified with the aid of the colours, the boundaries are more fluid than with the humanities and social sciences.

Computer Science Subjects as a Bridge to all Disciplines

The subject areas classified under computer science function almost as a bridge between the sciences and the humanities. The nucleus of the network is Applied Computer Science, which is intensively integrated in a wide range of clusters, as indicated by the radius of the circle. The expertise of PIs working at institutes of applied computer sciences and the neighbouring computer sciences (as well as various other, more focused subjects with a computer science connection) is in demand among partners in very different areas – from art history to textile engineering and from electrochemistry to neurology. Smaller in scope, but still performing a stable bridging function, are subject areas classified under economics and psychology.

Clear substructures can also be observed within the four scientific disciplines, for instance in the life sciences, where biology plays a central role – with biochemistry and biotechnology serving as bridges to the natural and engineering sciences. In the natural sciences, subjects classified under physics are often the common denominator, while in the humanities and social sciences, history, philosophy and sociology represent important hubs. Finally, the engineering sciences reveal a highly differentiated internal structure, with noticeably close relationships with the fundamental subject areas in the natural sciences.

All in all, it can be noted that the DFG-funded Clusters of Excellence are shaped in a decisive way by research teams working on a strongly cross-disciplinary basis. In the same way, it is hoped that these clusters will be able to address jointly the new challenges that often arise at the boundaries between subject areas.

4 Subject-based Funding Profiles of Research Institutions

The topic of this chapter is the subject-based profiles of universities and non-university research institutions in Germany on the basis of the figures presented in chapter 2.

The chapter begins with some information on the subject and funding area classifications used and the question of how the figures in this Funding Atlas are assigned to particular subject areas. In the next section, the funds awarded by the different providers considered here are compared, differentiated according to the scientific disciplines defined by the DFG. In section 4.3, university profiles are then examined specifically with respect to research areas, using the four disciplines familiar from previous editions of the Funding Atlas: humanities and social sciences, life sciences, natural sciences and engineering sciences.

In addition to absolute rankings and rankings adjusted for staff size, the DFG Funding Atlas features the traditional cartographic views that show regional clusters and cross-regional networking between research institutions in DFG-funded Coordinated Programmes.

4.1 Subject Classification of Funding Activities Reported in the DFG Funding Atlas

The meaningfulness of statistics on research and its funding generally varies from one subject area to another. It would make little sense to measure the research output of a philosopher by the number of patents he or she applied for or to gauge the output of engineering research (solely) by the number of journal papers listed in bibliographic databases. So when considering statistics it is important to distinguish between different subject areas, and this also applies to statistics on third-party funding. Although in recent years third-party funding has become a comparatively reliable and recognised standard for evaluation across all subject areas – legitimised for example by the fact that few subject areas nowadays do not benefit from some kind of third-party support – there is a tendency to underestimate how much the amount awarded varies from subject to subject. In the DFG Funding Atlas 2015, this was illustrated with the help of a diagram comparing total third-party funding per capita and that obtained from the DFG, for 14 research areas (DFG, 2015a: 52). The diagram shows clearly that the volume of third-party funding acquired in mechanical engineering is 9 to 11 times higher than in the humanities and social and behavioural sciences. There are also considerable differences between other research areas.

In a global comparison, the DFG is one of only a few research funding organisations whose funding activities are classified in detail by subject area. This is because its decision-making processes have always followed a subject-based procedure. In 2020, it will be 100 years since the DFG was first founded, after the devastation of the First World War, as the *Notgemeinschaft der Deutschen Wissenschaft* (Emergency Foundation of German Science). When the organisation was set up, expert committees were appointed whose elected members were responsible for reviewing proposals in their respective subject areas.

In 2003, as part of a comprehensive reform, these committees were replaced by the review board system. The review boards are no longer responsible for the actual review process, with reviews now being handled by around 15,000 reviewers from Germany and abroad (DFG, 2018: 183). Instead, their task in relation to the processing and reviewing of proposals is to compare and evaluate proposals on the basis of the reviews received and, if necessary, prioritise them in view of the available budget. The members of the 48 review boards are elected by the scientific

Table 4-1:
DFG system of review boards, research areas and scientific disciplines

Review board		Research area		Scientific discipline
101	Ancient cultures	Humanities	HUM	Humanities and social sciences
102	History			
103	Fine arts, music, theatre and media studies			
104	Linguistics			
105	Literary studies			
106	Social and cultural anthropology, non-European cultures, Jewish studies and religious studies			
107	Theology			
108	Philosophy			
109	Education research	Social and behavioural sciences	SOC	
110	Psychology			
111	Social sciences			
112	Economics			
113	Jurisprudence			
201	Basic biological and medical research	Biology	BIO	Life sciences
202	Plant sciences			
203	Zoology			
204	Microbiology, virology and immunology	Medicine	MED	
205	Medicine			
206	Neurosciences			
207	Agriculture, forestry and veterinary medicine	Agriculture, forestry and veterinary medicine	AFV	
301	Molecular chemistry	Chemistry	CHE	Natural sciences
302	Chemical solid state and surface research			
303	Physical and theoretical chemistry			
304	Analytical chemistry, method development (chemistry)			
305	Biological chemistry and food chemistry			
306	Polymer research			
307	Condensed matter physics	Physics	PHY	
308	Optics, quantum optics and physics of atoms, molecules and plasmas			
309	Particles, nuclei and fields			
310	Statistical physics, soft matter, biological physics, nonlinear dynamics			
311	Astrophysics and astronomy			
312	Mathematics	Mathematics	MAT	
313	Atmospheric science, oceanography and climate reasearch	Geosciences	GEO	
314	Geology and palaeontology			
315	Geophysics and geodesy			
316	Geochemistry, mineralogy and crystallography			
317	Geography			
318	Water research			
401	Production technology	Mechanical and industrial engineering	MIE	Engineering sciences
402	Mechanics and constructive mechanical engineering			
403	Process engineering, technical chemistry	Thermal engineering / process engineering	TPE	
404	Heat energy technology, thermal machines, fluid mechanics			
405	Materials engineering	Materials science and engineering	MSE	
406	Materials science			
407	System engineering	Computer science, systems and electrical engineering	CSE	
408	Electrical engineering and information technology			
409	Computer science			
410	Construction engineering and architecture	Construction engineering and architecture	CEA	

Note: As at 2018. Table Web-65 at www.dfg.de/fundingatlas shows further differentiation by 213 subject areas.
Corresponds to Tabelle 4-1 of the DFG Förderatlas 2018.

Table 4-2:
Participation[1)] in DFG, federal government and EU funding programmes for research by scientific discipline

Scientific discipline	DFG awards		Direct R&D project funding from the federal government		R&D funding in Horizon 2020	
	€m	%	€m	%	€m	%
Humanities and social sciences	1,285.2	15.6	445.9	4.2	147.3	3.7
Life sciences	2,751.1	33.3	1,770.0	16.8	823.5	20.9
Natural sciences	1,755.8	21.3	1,656.3	15.8	438.1	11.1
Engineering sciences	1,541.2	18.7	5,331.5	50.7	1,784.6	45.3
No subject classification	928.2	11.2	1,301.8	12.4	744.4	18.9
Overall	**8,261.5**	**100.0**	**10,505.6**	**100.0**	**3,937.8**	**100.0**

[1)] Funding for German and institutional recipients only.

Note: Corresponds to Tabelle 4-2 of the DFG Förderatlas 2018.

Data basis and sources:
Deutsche Forschungsgemeinschaft (DFG, German Research Foundation): DFG awards for 2014 to 2016.
EU Office of the BMBF: Participation in Horizon 2020. EU Framework Programme for Research and Innovation (project data as of 28 February 2017).
Federal Ministry for Economic Affairs and Energy (BMWi): Funding for the Central Innovation Programme for SMEs (ZIM) 2014 to 2016.
Federal Ministry of Education and Research (BMBF): Direct R&D project funding from the federal government 2014 to 2016 (PROFI project database).
Calculations by the DFG.

Table 4-3:
Number of AvH, DAAD and ERC funding recipients by scientific discipline

Scientific discipline	AvH funding recipients		DAAD funding recipients		ERC funding recipients[1)]	
	N	%	N	%	N	%
Humanities and social sciences	1,767	29.9	1,794	44.1	58	12.7
Life sciences	941	15.9	655	16.1	172	37.7
Natural sciences	2,469	41.8	957	23.5	136	29.8
Engineering sciences	724	12.3	586	14.4	90	19.7
Overall[2)]	**5,901**	**100.0**	**4,065**	**100.0**	**456**	**100.0**

[1)] ERC funding recipients in Germany are shown.
[2)] Including DAAD funding recipients without specification of the scientific discipline.

Note: Corresponds to Tabelle 4-3 of the DFG Förderatlas 2018.

Data basis and sources:
Alexander von Humboldt Foundation (AvH): Research visits by AvH guest researchers from 2012 to 2016.
EU Office of the BMBF: ERC funding in Horizon 2020. EU Framework Programme for Research and Innovation (project data as of 10 October 2017).
Figures include Starting Grants, Advanced Grants and Consolidator Grants.
German Academic Exchange Service (DAAD): Research visits by DAAD guest researchers 2012 to 2016.
Calculations by the DFG.

communities in Germany for four years at a time. The current 613 members stand for election in a particular field, the most recent total being 213 subject areas. The number and the make-up of individual review boards varies from one election to the next in response to ongoing developments, whether the emergence of new subject areas or the decline in importance of once significant ones.

In the Funding Atlas, DFG awards are aggregated on the basis of a classification into 48 research fields (as a synonym for the term 'review boards', which is reserved for the DFG bodies of that name[1]), 14 research areas and four scientific disciplines. Table 4-1 shows how these three levels fit into the DFG subject classification system[2]. Table Web-65 documents the fourth level of the 213 subject areas.

1 More information about the function, election and composition of the review boards and their subject areas is available at www.dfg.de/review_boards.

2 See also "DFG classification system" in the Glossary of Methodological Terms at www.dfg.de/funding atlas.

Federal, EU, DAAD and AvH Funding Measures Differentiated into Four Scientific Disciplines

Like the DFG, the DAAD and AvH also use subject classification systems when processing proposals. These are organised in a similar way to the DFG system and can therefore be easily transferred to the four scientific disciplines. To classify its funding, in its R&D planning system the federal government distinguishes between 51 key topics categorised under 17 funding areas. Each of these can be approximately assigned as a whole to one scientific discipline. Table Web-22 at www.dfg.de/fundingatlas shows how the key topics and funding areas in the federal government's R&D planning system were allocated to the scientific disciplines defined by the DFG for the purposes of the Funding Atlas. A similar principle applies to the EU programmes, which do not normally have any subject classification and therefore can also only be assigned to a discipline as a whole unit. However, the classification process has been substantially improved compared with the DFG Funding Atlas 2015. Whereas in this publication, funds awarded in European Research Council (ERC) and Marie Skłodowska-Curie programmes were still categorised as 'No subject classification', these funds are now also differentiated by discipline. This was made possible with the help of information on the subject-based scientific panels in which funding decisions were prepared.[3]

4.2 Focal Subject Areas of Funding Providers Represented in the DFG Funding Atlas

The funding providers covered in the Funding Atlas differ in their subject profiles and areas of particular interest. At first glance, a comparison of the values for EU funding and federal funding (see Table 4-2) seems to show considerable similarity. In both cases the engineering sciences are dominant. The life sciences and natural sciences each have similar shares, with the natural sciences being somewhat more weakly represented in EU funding and the life sciences correspondingly somewhat more strongly represented. For both providers, the humanities and social sciences account for just a small proportion of awarded funding. A look at DFG awards, on the other hand, shows a clearly different picture. The life sciences are dominant here, and the natural sciences are also relatively strongly represented. The humanities and social sciences are also much more in evidence than with the federal government and the EU, with a share of over 15%. By comparison, the engineering sciences account for a much smaller share than with the other two providers.

Success in acquiring ERC grants is regarded across Europe and worldwide as a sign of excellence. The ERC and the DFG have in common the fact that the proposals received are not influenced by any specific guidelines but simply follow the inherent needs of science. Against this background, it is notable that this similarity in funding philosophy is also reflected in a similarity in subject profile; it should be noted that, compared with the previous overview, the basis for calculation is not funds but the number of funded individuals (see Table 4-3). The proportions represented by the different disciplines vary by only a few percentage points, with the greatest difference being for the natural sciences, whose share for the ERC is 8.5 percentage points higher.

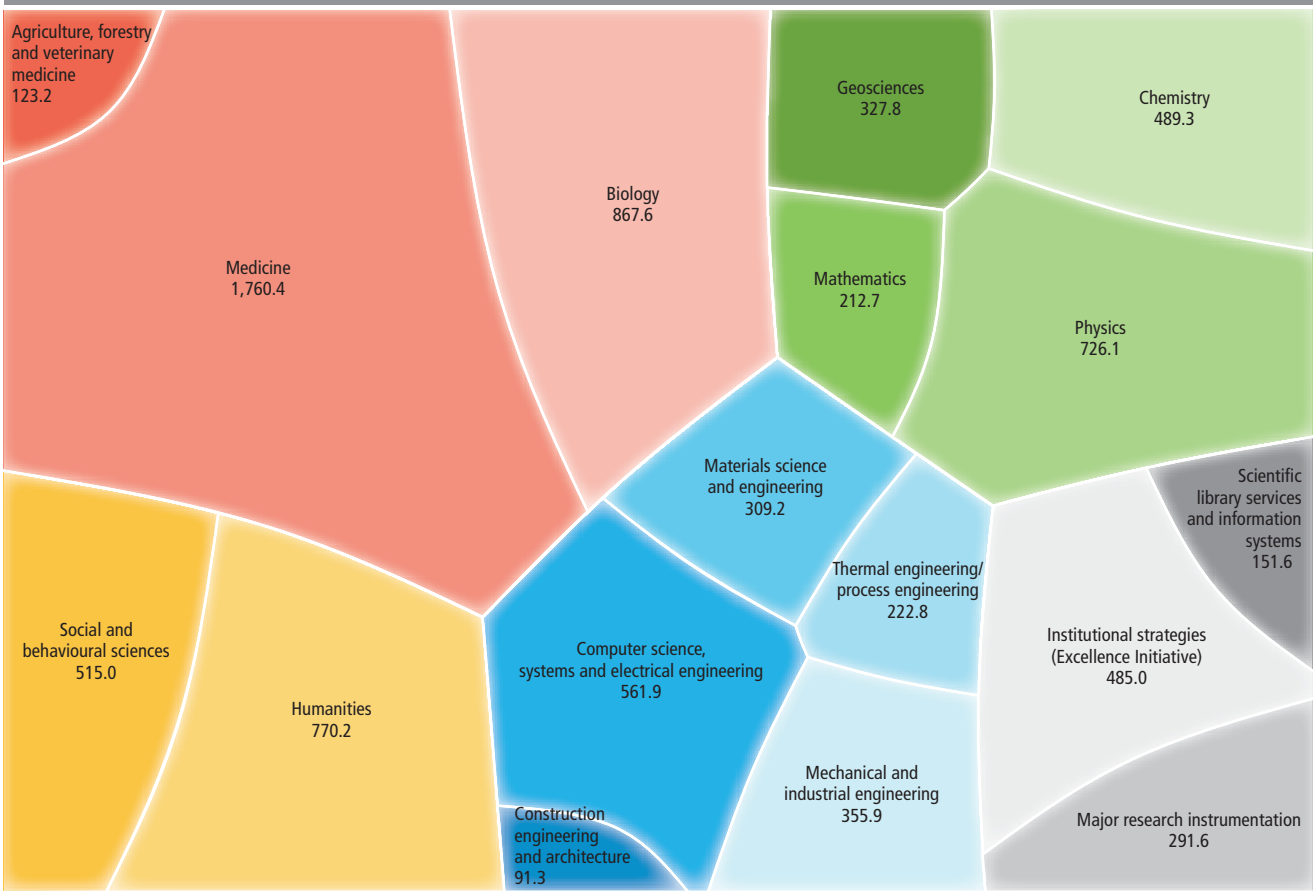
The other funding providers listed in Table 4-3 each have their own emphases. A strikingly high number of researchers in the humanities and social sciences benefit from DAAD funding (44%), while at the AvH the emphasis is on the natural sciences (42%).

It is important to bear in mind the differences described here in order to interpret the figures presented below. Staff members at technical universities are more likely to be successful in Horizon 2020 and with federal funding, because these programmes emphasise the spectrum of engineering sciences. By contrast, institutions with a strong emphasis on humanities and social sciences are more likely to benefit from DAAD-funded research visits.

Figures 4-1 to 4-3 show, for the DFG, the federal government and the EU, the proportions of the various research areas (DFG), funding areas (federal government) and funding programmes (EU) defined by the different funding providers, in graphic form. The areas shown in the three Voronoi dia-

3 See also „EU funding" in the Glossary of Methodological Terms at www.dfg.de/fundingatlas.

Figure 4-1:
DFG awards for 2014 to 2016 by research area



Note: Areas are proportionate to funding distribution. Figures are in millions of euros. Corresponds to Abbildung 4-1 of the DFG Förderatlas 2018.

Data basis and source:
Deutsche Forschungsgemeinschaft (DFG, German Research Foundation): DFG awards for 2014 to 2016.
Calculations by the DFG.

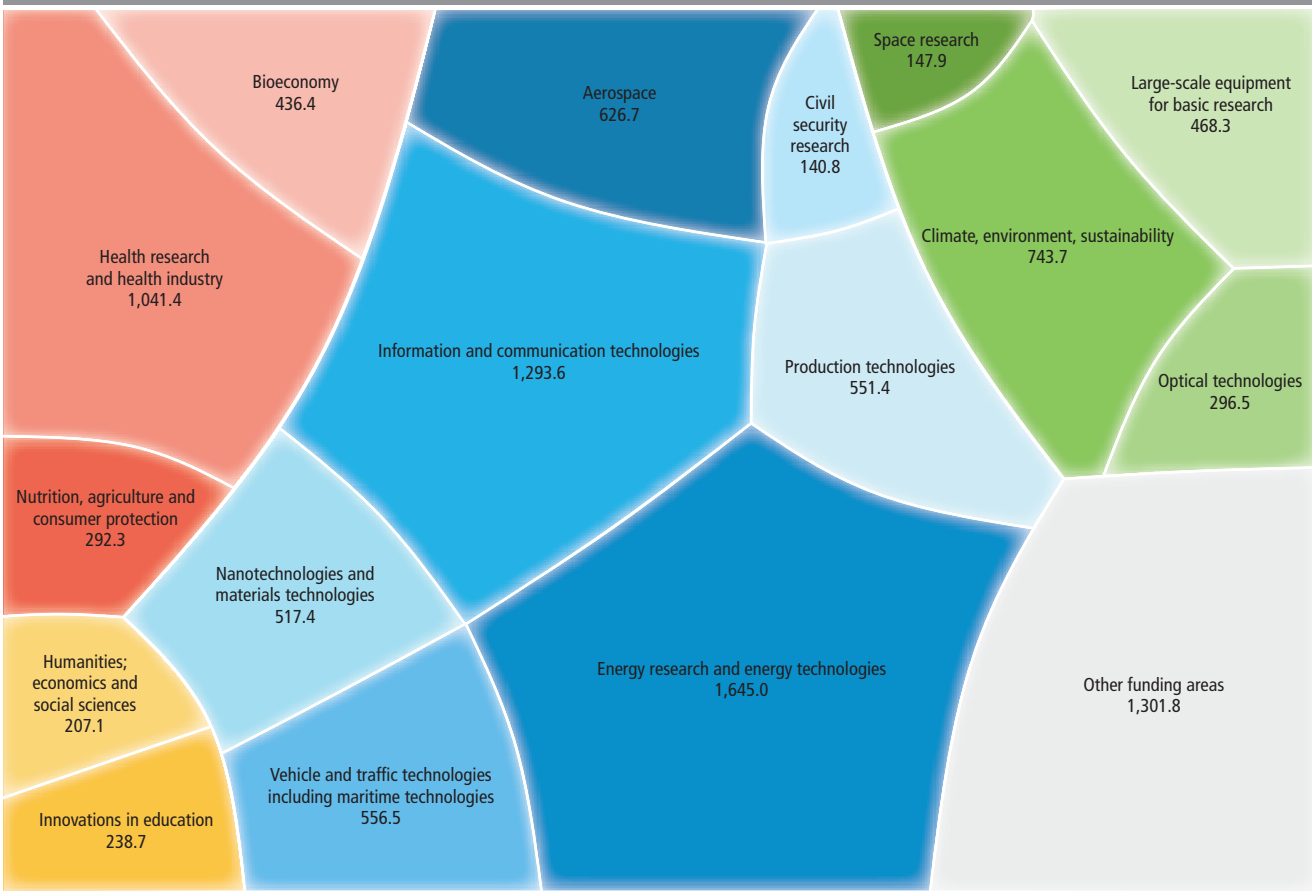
grams result proportionally from the share of the total funding volume represented by each field, in millions of euros. Clusters in similar colours bring together different units according to their categorisation in the four disciplines of the DFG classification system. The shares of funding instruments without a subject classification are also shown in shades of grey. For the DFG, for example, these are funds for Scientific Library Services and Information Systems; for the federal government, funds for the key topic of entrepreneur support (see also Table Web-22 at www.dfg.de/fundingatlas); and for the EU, funds for the objective of Science With And For Society (see Table Web-41 at www.dfg.de/fundingatlas).

Subject-based Profiles of Selected Universities in Online Content

Complementing the data presented in the print version of the Funding Atlas, the accompanying online material at www.dfg.de/fundingatlas includes institution-specific Voronoi diagrams for a selection of over 80 universities in the 'university views'.

Using the subject-area maps presented in the last four editions of the DFG Funding Atlas (e.g. DFG, 2015a: 104f.), it is possible to compare an institution's profile with the overall DFG profile and thus identify subject-area emphases compared with this overall average. The material can also be used to compare the profiles of two institutions.

Figure 4-2:
R&D project funding from the federal government 2014 to 2016 by funding area



Note: Areas are proportionate to funding distribution. Figures are in millions of euros. Corresponds to Abbildung 4-2 of the DFG Förderatlas 2018.

Data basis and sources
Federal Ministry for Economic Affairs and Energy (BMWi): Funding for the Central Innovation Programme for SMEs (ZIM) 2014 to 2016.
Federal Ministry of Education and Research (BMBF): Direct R&D project funding from the federal government 2014 to 2016 (PROFI project database).
Calculations by the DFG.

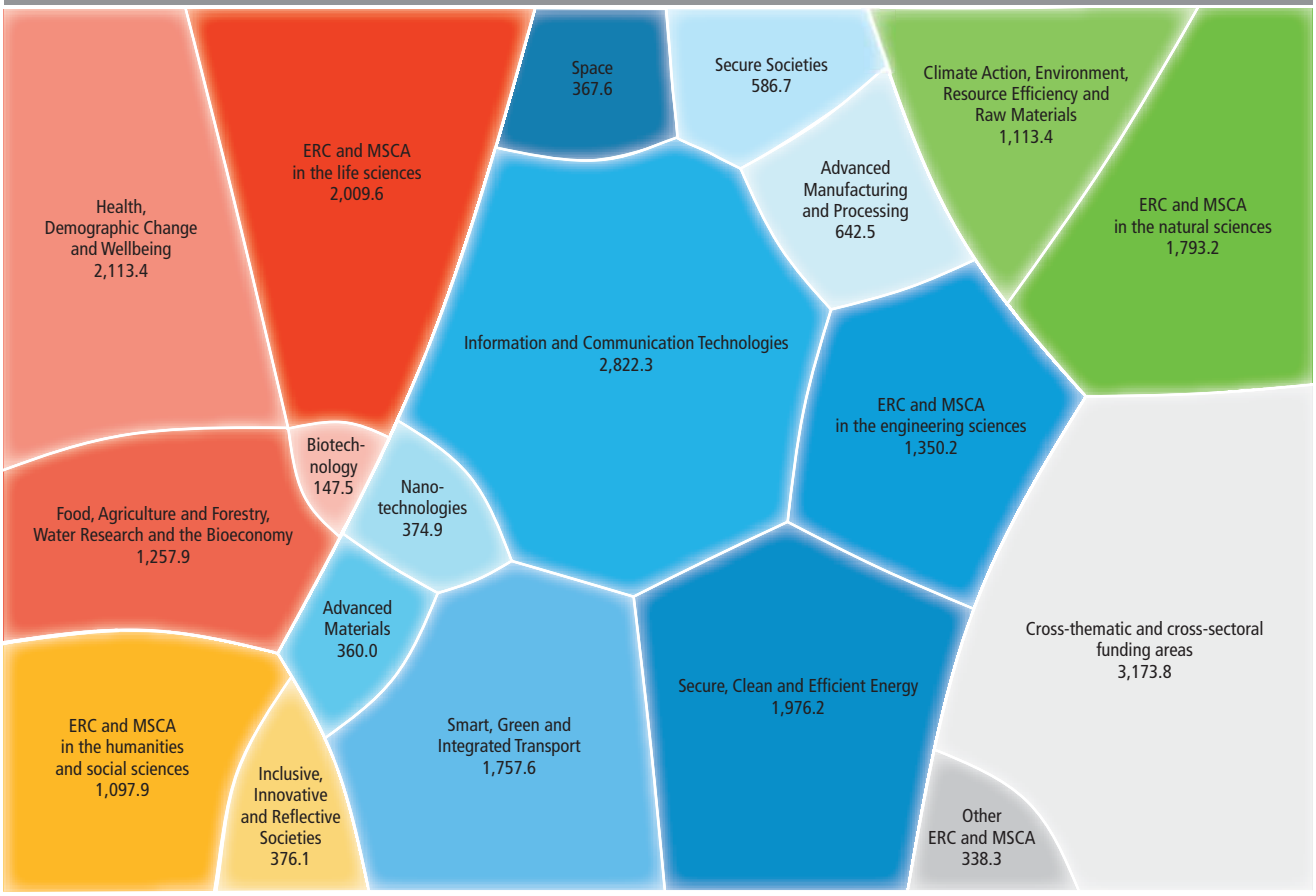
4.3 Funding Profiles in the Humanities and Social Sciences

The humanities and social sciences are the discipline with the largest number of staff at German universities. Approximately 44% of professors and a quarter of research staff work in this field (see Table Web-33 at www.dfg.de/fundingatlas). The humanities and social sciences have accounted for a stable proportion of between 15% and 16% of DFG funding for many years. A recent study shows that scholars in minor disciplines, such as Egyptology or theatre studies, also make extensive use of the DFG funding portfolio, both in the form of traditional research grants and through participation in cross-disciplinary Collaborative Research Centres and other DFG research groups (DFG, 2017b).

This makes the DFG the biggest provider of third-party funding for the humanities and social sciences compared with the EU and the federal government (see Table 4-4). Of the close to €1.3 billion awarded between 2014 and 2016, over 90% was allocated to university-based researchers. Prominent among non-university institutions are the Leibniz Association (WGL), which leads by some distance, followed by other institutions including a large number of museums and libraries.

Between 2014 and 2016, the funds acquired from the federal government for projects with a clear focus on the humanities and social sciences amounted to €446 million. In the case of the federal government, a much larger proportion of the volume went to non-university research institutions (24%); as with the DFG, and corresponding to its subject-area profile, the Leibniz Association represents the largest amount.

Figure 4-3:
Funding in Horizon 2020 – EU Framework Programme for Research and Innovation 2014 to 2016 by programme section



Note: Areas are proportionate to funding distribution. Figures are in millions of euros. Funding from the European Research Council (ERC) and Marie Skłodowska-Curie Actions (MSCA) are assigned to scientific disciplines in accordance with the subject orientation of the evaluating panel. Corresponds to Abbildung 4-3 of the DFG Förderatlas 2018.

Data basis and source:
EU Office of the BMBF: Participation in Horizon 2020. EU Framework Programme for Research and Innovation (project data as of 28 February 2017).
Calculations by the DFG.

The humanities and social sciences in Germany benefit to a smaller extent from EU funding, and mostly from ERC grants (see Table 4-3 and Table 4-6).

Tables Web-8, Web-19, Web-23, Web-24, Web-26 and Web-28 at www.dfg.de/fundingatlas provide further information about the amount of third-party funding awarded to universities and non-university research institutions by the DFG, the federal government and the EU, broken down by research area.

Clear Cluster Formation in Berlin

One aim of the structure-forming funding instruments offered by the DFG and through the Excellence Initiative is to support cooperation between individual researchers from different institutions. The cartographic network diagrams in the Funding Atlas illustrate this cooperation on the basis of joint participations in relevant research groups.

Between 2014 and 2016, in the humanities and social sciences researchers from around 140 institutions held leadership roles[4] in DFG funding instruments relevant to the analysis and in the Excellence Initiative. For the Excellence Initiative, for example, Graduate Schools and Clusters of Excellence are included along with the principal investigators named in the proposal and their respective institutions.[5] The network within the humanities and social sciences arising from these joint participations is shown in Figure 4-4. The diameter of the circles reflects the num-

4 See also "DFG project leaders" in the Glossary of Methodological Terms at www.dfg.de/fundingatlas.

5 See also "Excellence Initiative" in the Glossary of Methodological Terms at www.dfg.de/fundingatlas.

Table 4-4:
Participation[1)] in DFG, federal government and EU funding programmes for research by type of institution in the humanities and social sciences

Type of institution	DFG awards		Direct R&D project funding from the federal government		R&D funding in Horizon 2020	
	€m	%	€m	%	€m	%
Higher education institutions	**1,180.8**	**91.9**	**333.0**	**74.7**	**97.1**	**65.9**
Non-university research institutions	**104.4**	**8.1**	**105.2**	**23.6**	**44.1**	**30.0**
Fraunhofer-Gesellschaft (FhG)	0.1	0.0	5.1	1.1	3.8	2.6
Helmholtz Association (HGF)	0.1	0.0	0.2	0.0	5.6	3.8
Leibniz Association (WGL)	41.5	3.2	27.9	6.3	9.0	6.1
Max Planck Society (MPG)	8.2	0.6	5.3	1.2	9.2	6.3
Federal research institutions	13.0	1.0	9.4	2.1	0.3	0.2
Other research institutions	41.5	3.2	57.3	12.8	16.2	11.0
Industry and commercial enterprises			**7.7**	**1.7**	**6.1**	**4.1**
Institutions overall	**1,285.2**	**100.0**	**445.9**	**100.0**	**147.3**	**100.0**

[1)] Funding for German and institutional recipients only.

Note: Corresponds to Tabelle 4-4 of the DFG Förderatlas 2018.

Data basis and sources:
Deutsche Forschungsgemeinschaft (DFG, German Research Foundation): DFG awards for 2014 to 2016.
EU Office of the BMBF: Participation in Horizon 2020. EU Framework Programme for Research and Innovation (project data as of 28 February 2017).
Federal Ministry for Economic Affairs and Energy (BMWi): Funding for the Central Innovation Programme for SMEs (ZIM) 2014 to 2016.
Federal Ministry of Education and Research (BMBF): Direct R&D project funding by the federal government 2014 to 2016 (PROFI project database).
Calculations by the DFG.

ber of participations in the funding instruments, while the connecting lines indicate two or more joint participations.

Compared to the DFG Funding Atlas 2015, the number of joint participations has decreased both in the humanities and social sciences and in the networks of the other disciplines.[6] This is due to a particular effect in the last edition of the Funding Atlas, which reported on the years 2011 to 2013 and therefore on both the first (up to 2012) and the second phase of the Excellence Initiative (starting in 2012), and thus described a larger number of Clusters of Excellence and Graduate Schools.

Figure 4-4 clearly shows those higher education institutions which successfully proposed an especially large number of research groups in the humanities and social sciences, in particular the universities of **LMU Munich**, **U Tübingen**, **U Göttingen** and **U Hamburg**. An especially prominent position is occupied by **FU Berlin** and **HU Berlin,** with these two universities conducting 20 joint projects.

They have links with **TU Berlin**, **U Potsdam** and a variety of non-university institutes in the local area, for example the **Max Planck Institute for Human Development** and the **Social Science Center Berlin (WZB).**

Large Number of Universities in the Humanities and Social Sciences Acquire DFG Funding

In the humanities and social sciences, the trend towards deconcentration observed in previous years is continuing, i.e. DFG awards are being distributed over a growing number of institutions over time.

While in the Funding Atlas 2012 the amount for the university with the highest DFG funding volume was a factor of 17.8 higher than for the university in 40th place (DFG, 2012: 115), in the Funding Atlas 2015 this fell to 12.4 and it has now fallen to 11.3 (DFG, 2015a: 120).

The ranking of the universities based on DFG funding volume shows a number of changes compared with the previous period, both in absolute terms and relative to staff size (see Table 4-5). Between 2014 and 2016, **FU Berlin** and **HU Berlin** both increased

6 See also "Cartographic network analyses" in the Glossary of Methodological Terms at www.dfg.de/fundingatlas.

Figure 4-4:
Participations by research institutions in DFG-funded joint programmes and resulting collaborative relationships 2014 to 2016 in the humanities and social sciences

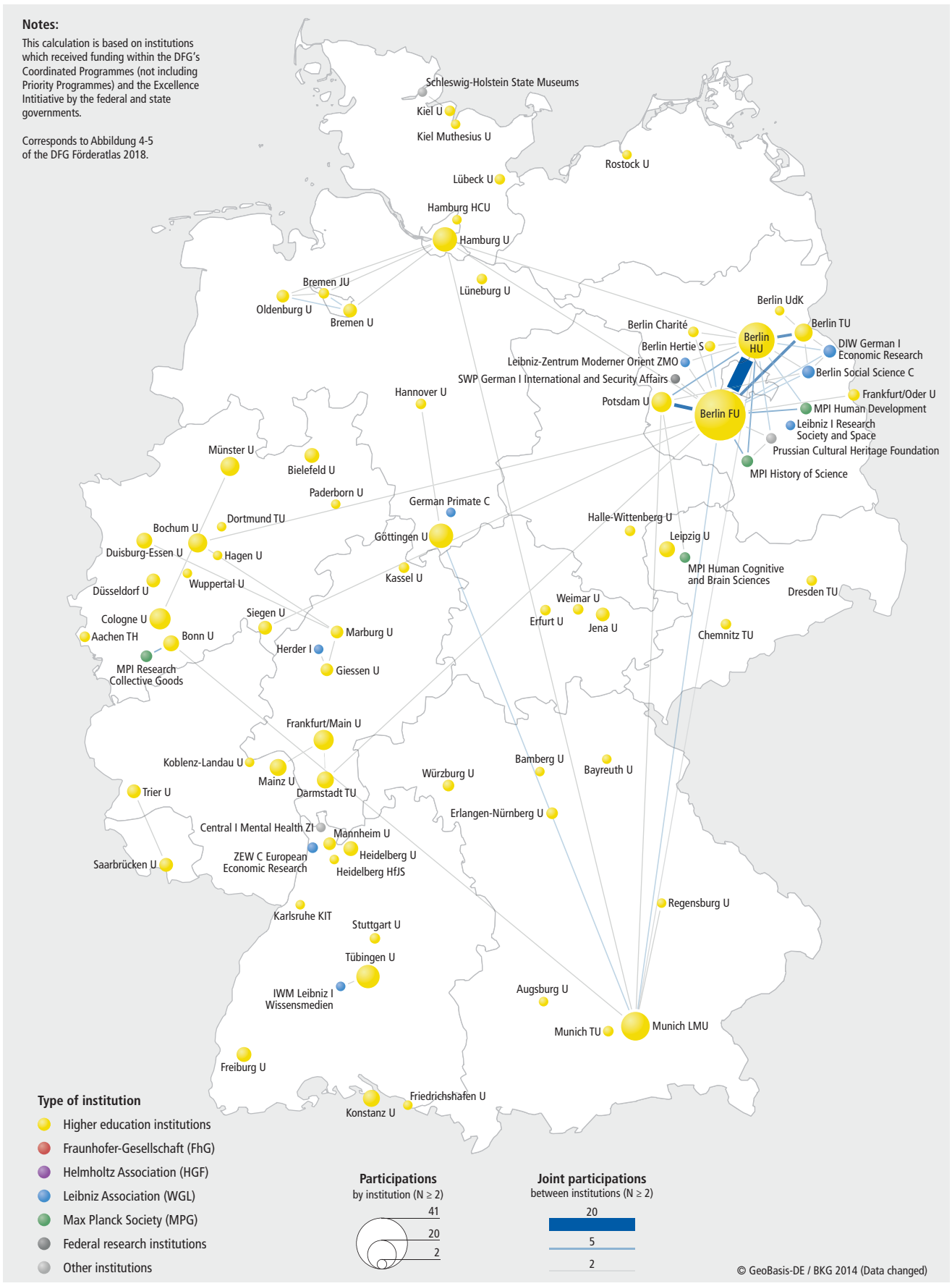


Table 4-5:
The higher education institutions with the highest DFG awards for 2014 to 2016 in absolute figures and relative to staff size in the humanities and social sciences

DFG awards (absolute)		DFG awards relative to size[1]					
Higher education institution	Total	Higher education institution	Professorial staff		Higher education institution	Researchers	
	€m		N	€ thousand per prof.		N	€ thousand per res.
Berlin FU	91.6	Konstanz U	126	305.8	Konstanz U	605	63.8
Berlin HU	72.6	Berlin FU	331	277.2	Berlin FU	1,445	63.4
Munich LMU	59.1	Stuttgart U	46	269.8	Berlin HU	1,386	52.4
Tübingen U	58.4	Tübingen U	240	243.6	Tübingen U	1,191	49.0
Frankfurt/Main U	56.3	Berlin HU	300	242.2	Berlin TU	223	41.9
Münster U	50.8	Freiburg U	142	237.7	Heidelberg U	1,006	41.7
Cologne U	42.4	Heidelberg U	183	229.6	Frankfurt/Main U	1,406	40.0
Heidelberg U	42.0	Berlin TU	43	216.7	Saarbrücken U	547	39.7
Konstanz U	38.6	Saarbrücken U	102	213.0	Bielefeld U	785	38.7
Hamburg U	35.4	Bielefeld U	161	188.4	Freiburg U	952	35.4
Freiburg U	33.7	Munich LMU	323	182.9	Münster U	1,549	32.8
Göttingen U	33.0	Frankfurt/Main U	320	175.8	Göttingen U	1,068	30.9
Bielefeld U	30.4	Münster U	292	173.8	Stuttgart U	407	30.5
Mannheim U	27.6	Mannheim U	164	168.5	Munich LMU	1,973	30.0
Bonn U	22.2	Göttingen U	212	155.7	Mannheim U	1,028	26.9
Saarbrücken U	21.7	Bremen JU	21	153.3	Giessen U	763	26.4
Mainz U	21.6	Düsseldorf U	130	127.5	Hamburg U	1,414	25.0
Giessen U	20.2	Giessen U	159	126.4	Bonn U	894	24.8
Leipzig U	19.2	Potsdam U	146	125.6	Düsseldorf U	704	23.5
Bochum U	18.5	Chemnitz TU	71	120.1	Jena U	789	23.4
Ranked 1–20	**795.3**	**Ranked 1–20**	**3,512**	**226.4**	**Ranked 1–20**	**20,136**	**39.5**
Other HEIs[2]	**385.5**	**Other HEIs[2]**	**18,468**	**20.9**	**Other HEIs[2]**	**51,567**	**7.5**
HEIs overall	**1,180.8**	**HEIs overall**	**21,980**	**53.7**	**HEIs overall**	**71,703**	**16.5**
of which: universities	**1,166.2**	**of which: universities**	**10,777**	**108.2**	**of which: universities**	**52,565**	**22.2**
Based on: N HEIs	**150**	**Based on: N HEIs**	**403**	**149**	**Based on: N HEIs**	**418**	**149**

[1] Only HEIs which employed more than 20 professors or 100 or more researchers in the scientific discipline under consideration during 2015 were included within the scope of this calculation.
[2] Please see Tables Web-6 and Web-8 at www.dfg.de/fundingatlas for data on other higher education institutions.

Note: Corresponds to Tabelle 4-5 of the DFG Förderatlas 2018.

Data basis and sources:
Deutsche Forschungsgemeinschaft (DFG, German Research Foundation): DFG awards for 2014 to 2016.
Federal Statistical Office (DESTATIS): Education and Culture. Personnel at Higher Education Institutions 2015. Special analysis of Subject-Matter Series 11, Series 4.4.
Calculations by the DFG.

their DFG funding, acquiring over €91 million and nearly €73 million respectively between 2014 and 2016. As in the previous period, the two Berlin universities therefore occupy the top two places in the ranking. They are now followed by **LMU Munich** with a good €59 million and **U Tübingen** with over €58 million. **U Saarbrücken** has made a clear jump in the ranking to reach 16th place.

When the figures are adjusted for staff size[7], **U Konstanz** leads the ranking. On average, a professor there acquired approximately €306,000 over the three-year period. It is followed by **FU Berlin**, which employs the largest number of professors in the humanities and social sciences in Germany after **U Cologne** and **U Hamburg**.

7 See also "University staff" in the Glossary of Methodological Terms at www.dfg.de/fundingatlas.

A Third of AvH Research Visits are in the Humanities and Social Sciences

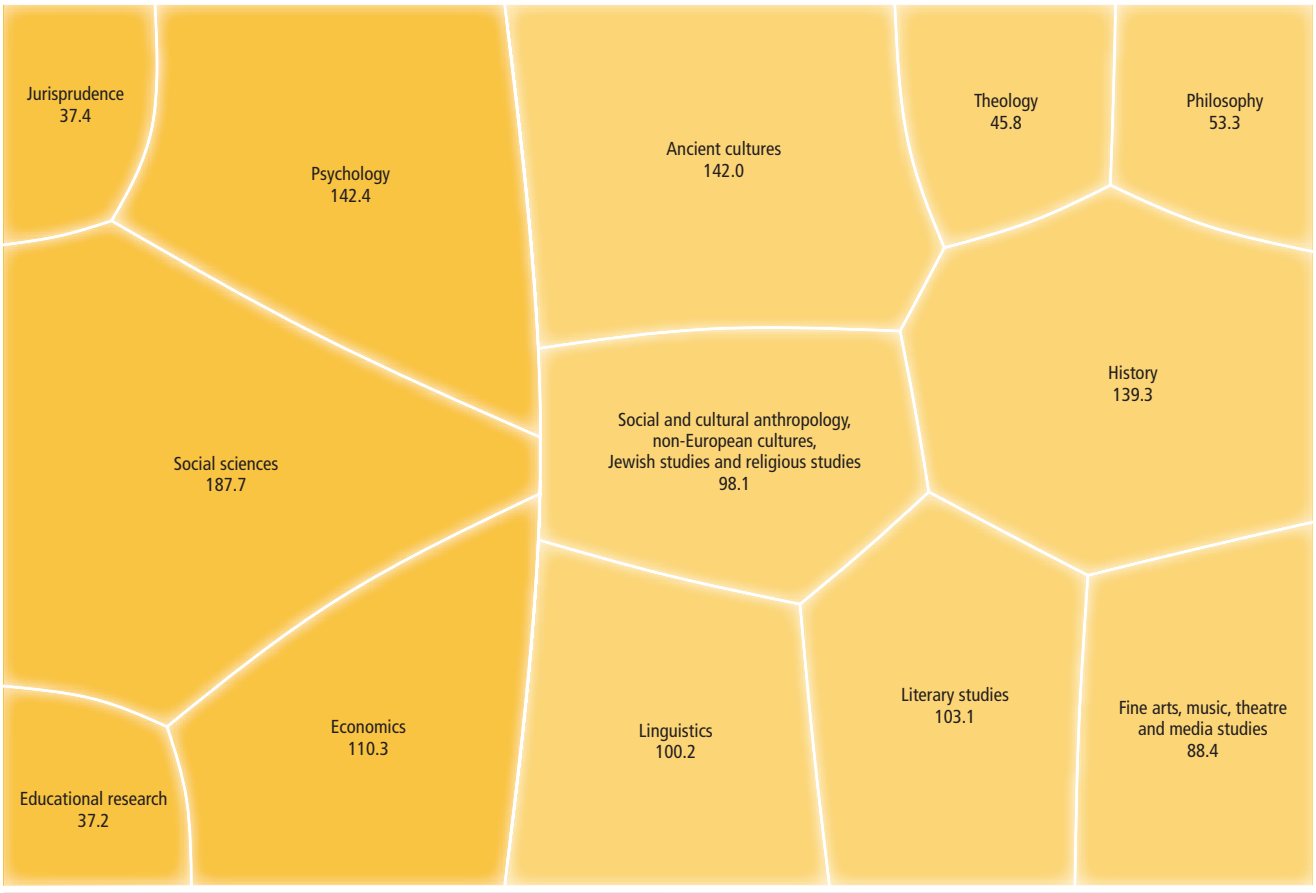
During the reporting period, the Alexander von Humboldt Foundation funded visits by approximately 1,500 foreign researchers in the humanities and social sciences to German universities (see Table 4-6 at www.dfg.de/fundingatlas). As in previous years, the largest number of AvH visitors were hosted by **FU Berlin**, **HU Berlin** and **LMU Munich**. Nearly a third of the almost 1,800 visiting researchers funded by the DAAD also spent their research visit at one of these three universities. In the previous reporting period, large universities based in major cities and very active in research were also very attractive to many foreign researchers in the humanities and social sciences.

Data on the number of DAAD, AvH and ERC award recipients at other universities as well as non-university research institutions can be found in Tables Web-27, Web-29, Web-30 and Web-31 at www.dfg.de/fundingatlas.

Voronoi Diagrams Provide a New Perspective on the Subject-area Diversity of DFG-funded Research

The Voronoi diagram in Figure 4-5 provides an overview of the deeper subject-based structure of DFG funding in the humanities and social sciences. It shows the distribution of DFG award amounts between 2014 and 2016, with proportion corresponding to area. The diagram is based on the 13 research fields that make up the two DFG research areas of Humanities and Social and Behavioural Sciences according to the DFG classification system (see Table 4-1). The humanities account for a little under two thirds of the total amount for this discipline, or €770 million. In the social and behavioural sciences, €515 mil-

Figure 4-5:
DFG awards for 2014 to 2016 by research field in the humanities and social sciences



Note: Areas are proportionate to funding distribution. Figures are in millions of euros. Corresponds to Abbildung 4-6 of the DFG Förderatlas 2018.

Data basis and source:
Deutsche Forschungsgemeinschaft (DFG, German Research Foundation): DFG awards for 2014 to 2016.
Calculations by the DFG.

lion was approved in the period under review. The award amounts in the individual research fields range from €37 million for the small research fields of educational research and law to just under €188 million for the largest research field, that of social sciences. Figure 4-5 is complemented by a representation of DFG funding in the form of a word cloud[8] at www.dfg.de/fundingatlas (Figure Web-7). The word cloud shows the 150 subject areas with the largest amount of funding (in German and in shortened form) according to a classification used by the Federal Statistical Office. The DFG funding volume for a subject area corresponds to the text size and proximity to the centre of the diagram, making it especially useful as an indication of focal areas.

Detailed analyses of DFG funding profiles by university and for non-university research institutions, broken down by research area and research field as distinguished in the Voronoi diagram above, can be found in tabular form at www.dfg.de/fundingatlas (Tables Web-8 and Web-19).

8 See also "Word cloud" in the Glossary of Methodological Terms at www.dfg.de/fundingatlas.

4.4 Funding Profiles in the Life Sciences

Between 2014 and 2016, the DFG approved a total of approximately €2.8 billion for research projects in the life sciences. This scientific discipline therefore obtained the largest proportion of total DFG awards with a 33% share.

In the life sciences, as with the other DFG disciplines, the largest proportion of DFG funding is awarded to university-based projects. Of a total of just under €2.8 billion, around 86% went to universities (see Table 4-6). A comparison with the DFG Funding Atlas 2015 shows an increase in the award amount by a little under €200 million (DFG, 2015a: 128).

For the years 2014 to 2016, EU funding in the life sciences amounted to approximately €820 million. At 19%, industry accounts for a similar proportion to the federal government, which contributes almost €1,800 million to life sciences research. As far as further distribution is concerned, it is noticeable that for the EU, universities account for less than half of funding and that non-university institutions in particular are very strongly represented with a 38% share. Alongside the Helmholtz Association, the Max Planck Society is particularly successful at obtaining EU funding.

Table 4-6:
Participation[1] in DFG, federal government and EU funding programmes for research by type of institution in the life sciences

Type of institution	DFG awards		Direct R&D project funding from the federal government		R&D funding in Horizon 2020	
	€m	%	€m	%	€m	%
Higher education institutions	**2,362.4**	**85.9**	**993.8**	**56.1**	**355.4**	**43.2**
Non-university research institutions	**388.7**	**14.1**	**483.9**	**27.3**	**310.4**	**37.7**
Fraunhofer-Gesellschaft (FhG)	1.2	0.0	64.0	3.6	18.2	2.2
Helmholtz Association (HGF)	99.1	3.6	100.8	5.7	72.9	8.8
Leibniz Association (WGL)	86.2	3.1	59.3	3.4	20.7	2.5
Max Planck Society (MPG)	132.0	4.8	36.8	2.1	82.9	10.1
Federal research institutions	17.2	0.6	51.1	2.9	33.0	4.0
Other research institutions	53.1	1.9	171.8	9.7	82.6	10.0
Industry and commercial enterprises			**292.4**	**16.5**	**157.7**	**19.1**
Institutions overall	**2,751.1**	**100.0**	**1,770.0**	**100.0**	**823.5**	**100.0**

[1] Funding for German and institutional recipients only.

Note: Corresponds to Tabelle 4-9 of the DFG Förderatlas 2018.

Data basis and sources:
Deutsche Forschungsgemeinschaft (DFG, German Research Foundation): DFG awards for 2014 to 2016.
EU Office of the BMBF: Participation in Horizon 2020. EU Framework Programme for Research and Innovation (project data as of 28 February 2017).
Federal Ministry for Economic Affairs and Energy (BMWi): Funding for the Central Innovation Programme for SMEs (ZIM) 2014 to 2016.
Federal Ministry of Education and Research (BMBF): Direct R&D project funding by the federal government 2014 to 2016 (PROFI project database).
Calculations by the DFG.

An overview of the universities and non-university research institutions which obtain DFG, federal government and EU funding in the life sciences can be found in Tables Web-9, Web-19, Web-23, Web-24, Web-26 and Web-28 at www.dfg.de/funding atlas.

Clear Cluster Formation across Different Types of Institutions in the Munich and Berlin Areas

Figure 4-6 represents the networking in the life sciences in the same manner as is described in section 4.3. In total, researchers from 64 universities and 119 non-university research institutions are involved in DFG research groups and those funded through the Excellence Initiative. Figure 4-6 reveals an exceptionally dense cross-regional network of cooperation. A distinct cluster of university and non-university institutions can be seen in the Berlin area, with **Charité Berlin**, **FU Berlin**, **HU Berlin** and the **Max Delbrück Center for Molecular Medicine (MDC)**. The Munich region, too, is home to a strong regionally interacting DFG-funded network with **LMU Munich**, **TU Munich**, **Helmholtz-Zentrum München** (German Research Center for Environmental Health) and the **Max Planck Institute of Biochemistry (MPIB)**. Munich is also one of the regions with an above-average number of links to geographically distant regions. For example, there is close cooperation between Munich's major universities and **U Freiburg**. Finally, special mention should be made of the Göttingen region, which has a dense cooperation cluster with a diverse range of non-university research institutions.

For example, Göttingen is home to the **German Primate Center (DPZ)** and the **Max Planck Institute for Dynamics and Self-Organization (MPIDS)**.

LMU Munich Still the Most Successful in DFG Funding in the Life Sciences

Table 4-7 shows the universities with the highest DFG funding (in absolute terms and relative to staff size[9]) in the life sciences from 2014 to 2016. The low number of funded universities (92) compared with the other disciplines demonstrates how DFG funding is concentrated in a small number of locations. This can be explained by the focus on medical research, much of which takes place at universities with their own clinical facilities (see below). Leading the table with €147 million is **LMU Munich**. Other institutions with award amounts over €100 million were **U Heidelberg**, **U Freiburg** and **U Göttingen**. All these institutions participate in the Excellence Initiative in the life sciences and have enlarged their funding volumes compared to the DFG Funding Atlas 2015. Two universities have significantly improved their position compared with the last reporting period: **U Frankfurt/Main** (from 14th to 8th place) and **U Münster** (from 15th to 10th place).

In the per-capita adjusted view of professor-level staff, the largest volume of DFG funding went to **U Freiburg**, closely followed by **U Konstanz**. The latter is an exception to the extent that it does not have a medical faculty, but it does carry out many projects in its Faculty of Sciences which at the DFG were evaluated by review boards such as Basic Research in Biology and Medicine.

U Göttingen Still Much in Demand among AvH and DAAD Funding Recipients – Munich Offers Attractive Conditions for ERC Grantees

U Göttingen is particularly attractive to international researchers. As in the DFG Funding Atlas 2015, it attracts the largest number of AvH and DAAD funding recipients (see Table Web-48 at www.dfg.de/fundingatlas). Especially attractive to ERC grantees is Munich with its two major universities, **LMU Munich** and **TU Munich**.

A total of 25 ERC grantees opted to carry out their projects at one of these two universities, corresponding to a 28% share of all ERC grantees in the life sciences working at German universities.

Detailed information on the number of AvH, DAAD and ERC funding recipients per university and non-university research institution can be found in Tables Web-27, Web-29, Web-30 and Web-31 at www.dfg.de/fundingatlas.

9 See also "University staff" in the Glossary of Methodological Terms at www.dfg.de/fundingatlas.

Figure 4-6:
Participations by research institutions in DFG-funded joint programmes and resulting collaborative relationships 2014 to 2016 in the life sciences

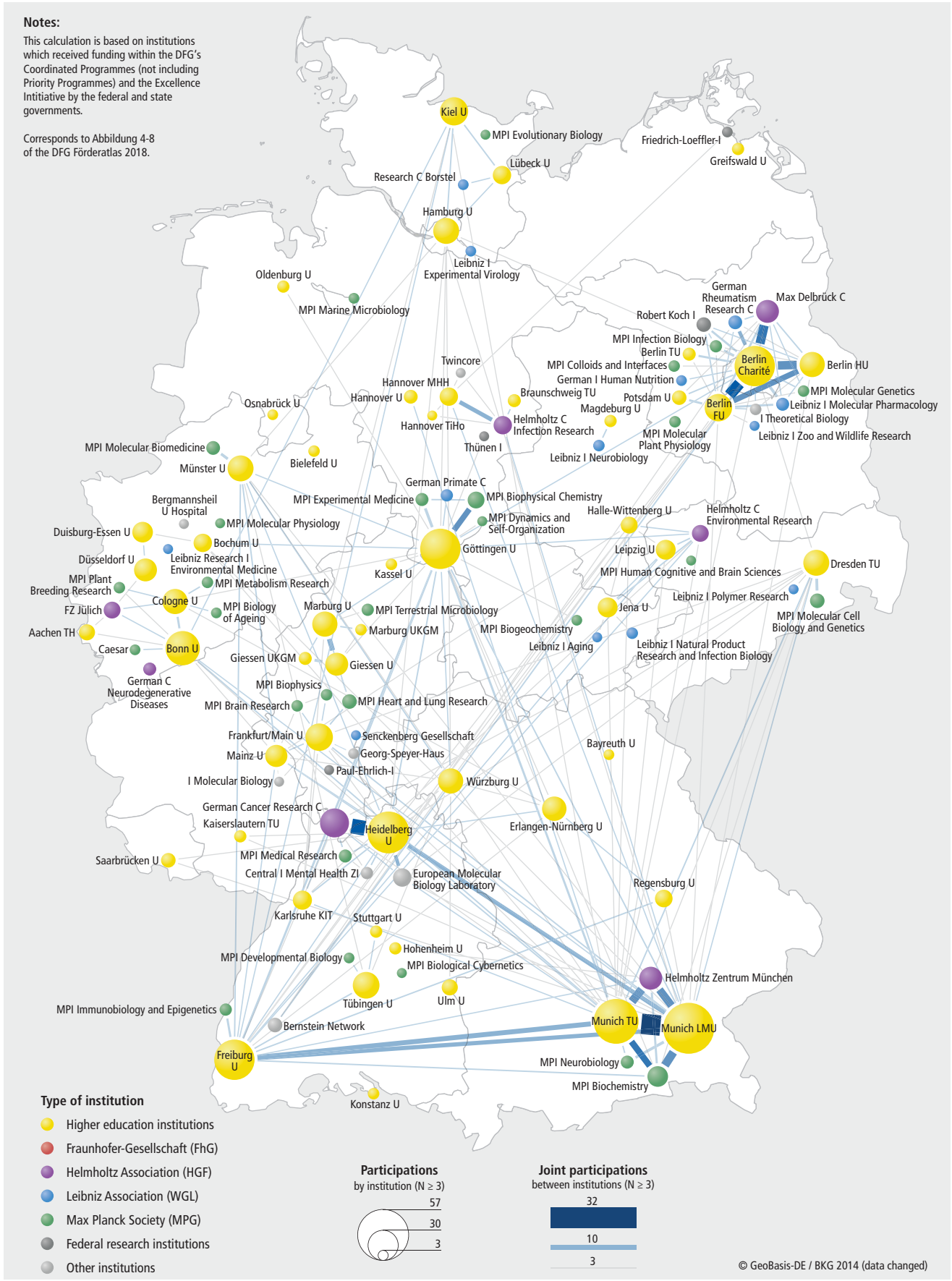


Table 4-7:
The higher education institutions with the highest DFG awards for 2014 to 2016 in absolute figures and relative to staff size in the life sciences

DFG awards (absolute)		DFG awards relative to size[1]					
Higher education institution	Total	Higher education institution	Professorial staff		Higher education institution	Researchers	
	€m		N	€ thousand per prof.		N	€ thousand per res.
Munich LMU	147.3	Freiburg U	160	798.0	Konstanz U	223	93.1
Heidelberg U	130.3	Konstanz U	27	760.2	Kaiserslautern TU	129	57.0
Freiburg U	127.5	Munich TU	150	664.0	Oldenburg U	328	56.8
Göttingen U	116.0	Heidelberg U	211	617.1	Hannover U	173	54.6
Munich TU	99.8	Frankfurt/Main U	145	605.5	Osnabrück U	249	53.1
Tübingen U	93.3	Munich LMU	246	597.9	Karlsruhe KIT	161	51.3
Berlin FU	89.8	Göttingen U	195	595.2	Bochum U	546	47.2
Frankfurt/Main U	87.8	Tübingen U	159	586.2	Göttingen U	2,548	45.5
Bonn U	85.3	Dresden TU	134	582.7	Frankfurt/Main U	2,010	43.7
Münster U	83.9	Cologne U	152	545.9	Freiburg U	3,104	41.1
Cologne U	83.0	Münster U	160	523.7	Bayreuth U	161	40.7
Dresden TU	78.2	Hannover MHH	152	511.6	Bielefeld U	285	39.0
Hannover MHH	77.8	Magdeburg U	49	503.8	Munich TU	2,561	39.0
Würzburg U	70.0	Kiel U[3]	167	497.0	Stuttgart U	129	38.6
Berlin HU	69.4	Berlin FU	196	458.9	Dresden TU	2,117	37.0
Erlangen-Nürnberg U	68.7	Ulm U	103	441.7	Braunschweig TU	221	36.8
Hamburg U	62.9	Oldenburg U	42	440.4	Darmstadt TU	140	36.5
Düsseldorf U	59.8	Bonn U	201	423.5	Munich LMU	4,082	36.1
Leipzig U	50.3	Bochum U	62	412.9	Tübingen U	2,742	34.0
Kiel U	47.1	Erlangen-Nürnberg U	167	411.5	Heidelberg U	3,858	33.8
Ranked 1–20	**1,728.1**	**Ranked 1–20**	**2,881**	**599.9**	**Ranked 1–20**	**25,766**	**67.1**
Other HEIs[2]	**634.4**	**Other HEIs[2]**	**3,982**	**159.3**	**Other HEIs[2]**	**55,833**	**11.4**
HEIs overall	**2,362.4**	**HEIs overall**	**6,862**	**344.3**	**HEIs overall**	**81,598**	**29.0**
of which: universities	**2,360.7**	**of which: universities**	**5,661**	**417.0**	**of which: universities**	**79,063**	**29.9**
Based on: N HEIs	**92**	**Based on: N HEIs**	**189**	**79**	**Based on: N HEIs**	**197**	**79**

[1] Only HEIs which employed more than 20 professors or 100 or more researchers in the scientific discipline under consideration during 2015 were included within the scope of this calculation.
[2] Please see Table Web-6 and Web-9 at www.dfg.de/fundingatlas for data on other higher education institutions.
[3] For figures relative to number of professors, including the University Medical Center Schleswig-Holstein. Please see "University staff" in the Glossary of Methodological Terms at www.dfg.de/fundingatlas for more information.

Note: Corresponds to Tabelle 4-10 of the DFG Förderatlas 2018.

Data basis and sources:
Deutsche Forschungsgemeinschaft (DFG, German Research Foundation): DFG awards for 2014 to 2016.
Federal Statistical Office (DESTATIS): Education and Culture. Personnel at Higher Education Institutions, 2015. Special analysis of Subject-Matter Series 11, Series 4.4.
Calculations by the DFG.

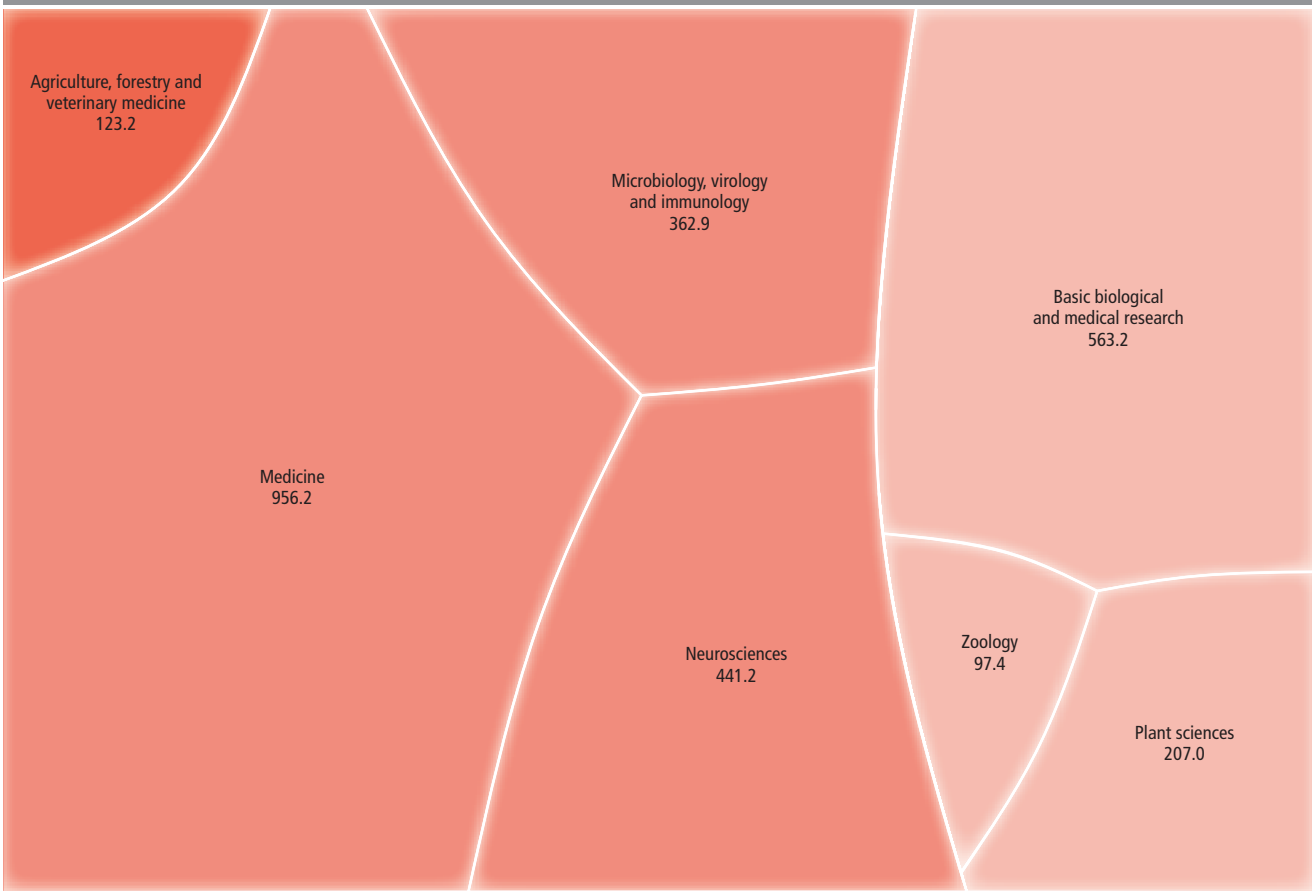
Research Field of Medicine is a Focal Area of DFG-funded Research

Figure 4-7 shows the proportions of DFG funding for the life sciences represented by the seven research fields that make up this discipline, in the Voronoi format, with proportion therefore corresponding to area. The largest amount was acquired by researchers for projects classified in the research field of medicine. Between 2014 and 2016, around €956 million was awarded for research projects in this field. It is followed by basic research in biology and medicine and by neurosciences, with €563 million and €441 million respectively.

DFG funding in the life sciences is also depicted in the form of a word cloud[10] at www.

10 See also "Word cloud" in the Glossary of Methodological Terms at www.dfg.de/fundingatlas.

Figure 4-7:
DFG awards for 2014 to 2016 by research field in the life sciences



Note: Areas are proportionate to funding distribution. Figures are in millions of euros. Corresponds to Abbildung 4-9 of the DFG Förderatlas 2018.

Data basis and source:
Deutsche Forschungsgemeinschaft (DFG, German Research Foundation): DFG awards for 2014 to 2016.
Calculations by the DFG.

dfg.de/fundingatlas (Figure Web-8) (see section 4.3). Here too, it can be seen that medical institutes are the main locations of DFG-funded research in the life sciences.

Special Evaluation for University Medical Institutions

The separate examination of DFG awards at university medical institutions, included for the first time in the Funding Atlas 2012 (DFG, 2012: 165ff.), features again in this edition. Updated analyses prepared in collaboration with the German Medical Faculty Association[11] can be found in Tables Web-20 and Web 21 at www.dfg.de/fundingatlas.

11 See www.mft-online.de and www.landkarte-hochschulmedizin.de (websites in German only).

Detailed analyses of DFG funding profiles by university and for non-university research institutions, broken down by research area and research field as distinguished in the Voronoi diagram above, can be found in tabular form at www.dfg.de/fundingatlas (Tables Web-9 and Web-19).

4.5 Funding Profiles in the Natural Sciences

Compared to the last reporting period (2011 to 2013), DFG awards for natural sciences projects at universities and non-university research institutions have increased by 4.5% to over €1.7 billion (see Table 4-15). In the same period, the funding areas classified within the natural sciences by the federal government accounted for a similarly high amount of over €1.6 billion. However, these two funding providers serve very dif-

ferent target groups. While the DFG primarily supported university-based research, which accounts for almost 87% of its awards, researchers at non-university research institutions obtained the largest proportion of federal funding at 44%. In this discipline, financial support from the EU is comparatively low compared to the DFG and the federal government, even taking into account ERC and Marie Skłodowska-Curie grants, which in this Funding Atlas are split into four scientific disciplines for the first time.

Overviews of the universities and non-university research institutions in receipt of DFG, federal government and EU funding in the natural sciences can be found in Tables Web-10, Web-19, Web-23, Web-24, Web-26 and Web-28 at www.dfg.de/fundingatlas.

Inter-institutional Cooperation in the Natural Sciences is Particularly Well Developed

DFG funding in the natural sciences is strongly networked across Germany. This is illustrated in Figure 4-8 on the basis of joint institutional participations in DFG programmes, including the Excellence Initiative funding lines of Graduate Schools and Clusters of Excellence (see section 4.3).

In total, 69 universities and 91 non-university institutions participated in DFG-funded joint programmes during the period in question. The diagram also clearly shows that the natural sciences are characterised by both strongly networked regional clusters, for instance in Berlin and Munich, and inter-regional cooperation. The fact that the network appears less dense than in the Funding Atlas 2015 is due to the fact that the threshold for the links represented has been increased in the interests of clarity. It should be noted that, as before, only Clusters of Excellence and Graduate Schools in the second funding period are taken into consideration (see section 4.3).

Among non-university research institutions, institutes of the Max Planck Society are involved with notable frequency in the network of DFG joint programmes. Examples of well-networked Max Planck Institutes include the **MPI of Colloids and Interfaces (MPI-KG)** in Potsdam and the **MPI for Biophysical Chemistry** in Göttingen.

Table 4-8:
Participation[1] in DFG, federal government and EU funding programmes for research by type of institution in the natural sciences

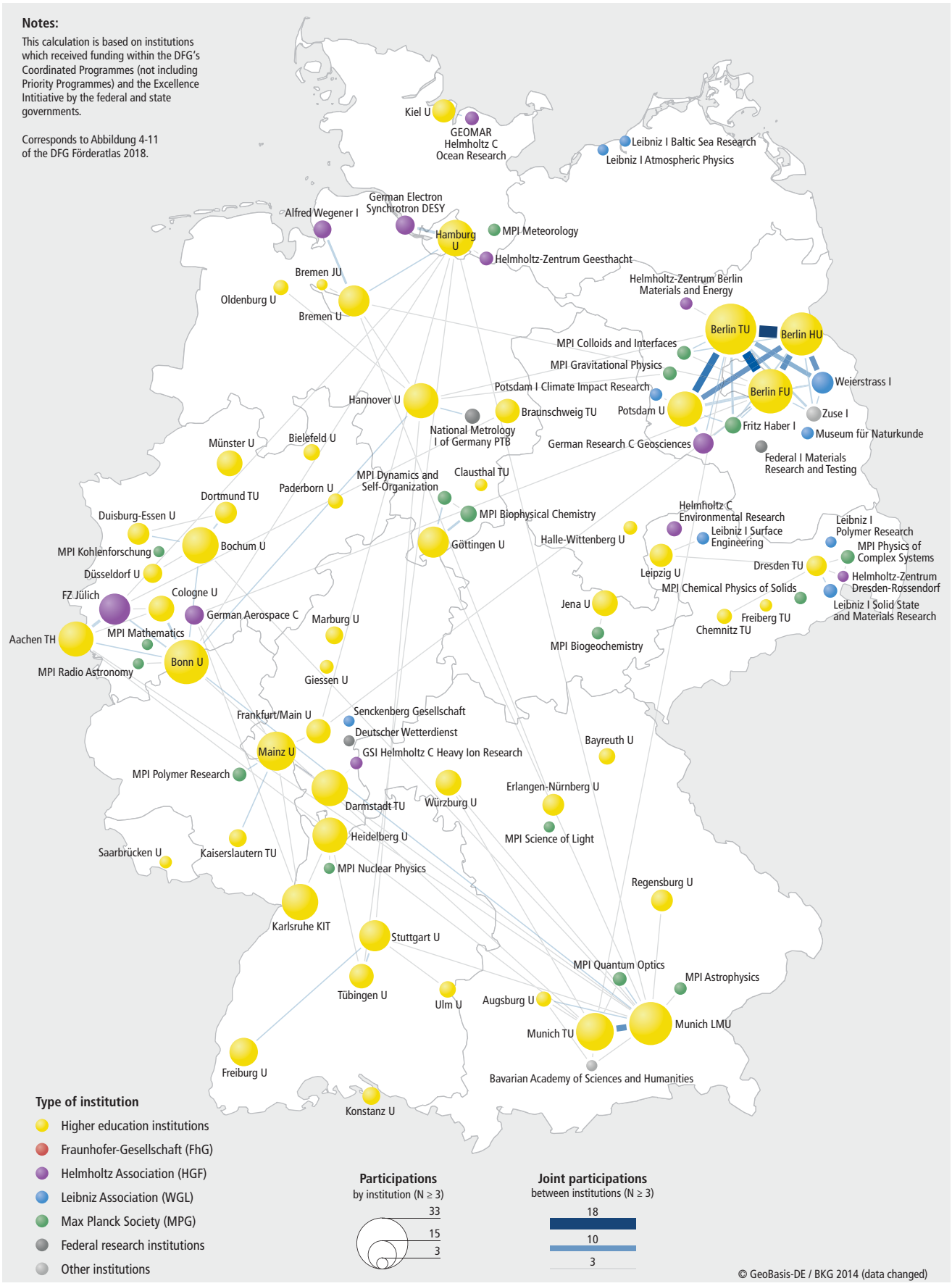
Type of institution	DFG awards		Direct R&D project funding from the federal government		R&D funding in Horizon 2020	
	€m	%	€m	%	€m	%
Higher education institutions	**1,523.6**	**86.8**	**623.3**	**37.6**	**190.2**	**43.4**
Non-university research institutions	**232.2**	**13.2**	**726.8**	**43.9**	**202.6**	**46.2**
Fraunhofer-Gesellschaft (FhG)	2.3	0.1	57.9	3.5	9.4	2.1
Helmholtz Association (HGF)	72.5	4.1	266.5	16.1	64.4	14.7
Leibniz Association (WGL)	51.0	2.9	67.9	4.1	27.0	6.2
Max Planck Society (MPG)	81.2	4.6	96.5	5.8	61.2	14.0
Federal research institutions	9.5	0.5	43.6	2.6	3.8	0.9
Other research institutions	15.7	0.9	194.5	11.7	36.7	8.4
Industry and commercial enterprises			**306.2**	**18.5**	**45.4**	**10.4**
Institutions overall	**1,755.8**	**100.0**	**1,656.3**	**100.0**	**438.1**	**100.0**

[1] Funding for German and institutional recipients only.

Note: Corresponds to Tabelle 4-15 of the DFG Förderatlas 2018.

Data basis and sources:
Deutsche Forschungsgemeinschaft (DFG, German Research Foundation): DFG awards for 2014 to 2016.
EU Office of the BMBF: Participation in Horizon 2020. EU Framework Programme for Research and Innovation (project data as of 28 February 2017).
Federal Ministry for Economic Affairs and Energy (BMWi): Funding for the Central Innovation Programme for SMEs (ZIM) 2014 to 2016.
Federal Ministry of Education and Research (BMBF): Direct R&D project funding from the federal government 2014 to 2016 (PROFI project database).
Calculations by the DFG.

Figure 4-8:
Participations by research institutions in DFG-funded joint programmes and resulting collaborative relationships 2014 to 2016 in the natural sciences



Among universities, **FU Berlin**, **HU Berlin** and **TU Berlin** are especially active, with the two major Bavarian universities of **LMU Munich** and **TU Munich** being readily visible in the network. **U Bonn**, **U Mainz** and **U Hamburg** are also among the institutions with the largest number of participations in DFG joint programmes.

U Mainz Attracts the Most DFG Funding in the Natural Sciences

DFG funding in the natural sciences is concentrated at 96 universities. In the ranking of absolute DFG funding amounts, one very strong group is clearly identifiable within this discipline, consisting of **U Mainz**, **U Hamburg** and **U Bonn**, which each received between €64 and approximately €70 million (see Table 4-9). Also clearly visible in the cartographic

Table 4-9:
The higher education institutions with the highest DFG awards for 2014 to 2016 in absolute figures and relative to staff size in the natural sciences

DFG awards (absolute)		DFG awards relative to size[1]					
Higher education institution	Total	Higher education institution	Professorial staff		Higher education institution	Researchers	
	€m		N	€ thousand per prof.		N	€ thousand per res.
Mainz U	69.6	Mainz U	107	652.0	Mainz U	860	81.0
Hamburg U	68.9	Regensburg U	57	590.4	Berlin HU	596	73.7
Bonn U	64.2	Bremen U	86	573.7	Bremen U	677	72.8
Munich LMU	58.6	Heidelberg U	89	565.6	Heidelberg U	722	69.6
Munich TU	55.7	Berlin TU	91	536.4	Berlin TU	717	67.7
Heidelberg U	50.3	Karlsruhe KIT	95	514.4	Regensburg U	500	67.4
Bremen U	49.2	Bonn U	128	501.5	Bonn U	984	65.3
Karlsruhe KIT	48.6	Hamburg U	142	484.0	Hamburg U	1,153	59.8
Berlin TU	48.6	Berlin HU	92	479.5	Kaiserslautern TU	343	59.1
Aachen TH	48.1	Munich LMU	124	472.0	Göttingen U	762	57.7
Münster U	47.8	Göttingen U	95	463.6	Bielefeld U	327	57.4
Göttingen U	44.0	Konstanz U	40	458.6	Darmstadt TU	599	56.4
Berlin HU	43.9	Munich TU	122	455.4	Halle-Wittenberg U	315	55.6
Berlin FU	41.7	Stuttgart U	64	445.0	Karlsruhe KIT	899	54.1
Hannover U	39.0	Aachen TH	112	430.5	Berlin FU	785	53.1
Cologne U	36.5	Freiburg U	63	427.6	Hannover U	759	51.3
Bochum U	36.2	Hannover U	93	418.3	Bochum U	705	51.3
Erlangen-Nürnberg U	35.3	Bochum U	94	386.7	Konstanz U	362	51.2
Darmstadt TU	33.8	Darmstadt TU	89	379.6	Cologne U	725	50.4
Regensburg U	33.7	Cologne U	98	374.3	Bayreuth U	491	49.2
Ranked 1–20	**953.7**	**Ranked 1–20**	**1,880**	**507.4**	**Ranked 1–20**	**13,279**	**71.8**
Other HEIs[2]	**569.9**	**Other HEIs[2]**	**3,173**	**179.6**	**Other HEIs[2]**	**20,441**	**27.9**
HEIs overall	**1,523.6**	**HEIs overall**	**5,053**	**301.5**	**HEIs overall**	**33,721**	**45.2**
of which: universities	**1,521.7**	**of which: universities**	**4,362**	**348.9**	**of which: universities**	**32,292**	**47.1**
Based on: N HEIs	**96**	**Based on: N HEIs**	**144**	**86**	**Based on: N HEIs**	**146**	**86**

[1] Only HEIs which employed more than 20 professors or 100 or more researchers in the scientific discipline under consideration during 2015 were included within the scope of this calculation.
[2] Please see Tables Web-6 and Web-10 at www.dfg.de/fundingatlas for data on other higher education institutions.

Note: Corresponds to Tabelle 4-16 of the DFG Förderatlas 2018.

Data basis and sources:
Deutsche Forschungsgemeinschaft (DFG, German Research Foundation): DFG awards for 2014 to 2016.
Federal Statistical Office (DESTATIS): Education and Culture. Personnel at Higher Education Institutions, 2015. Special analysis of Subject-Matter Series 11, Series 4.4.
Calculations by the DFG.

network (Figure 4-8) are **LMU Munich** and **TU Munich**, with a funding volume of €59 million and €56 million respectively.

In terms of DFG funding amounts adjusted for staff size[12], it can be noted that a high absolute DFG funding amount in this discipline usually corresponds to a high per-capita funding volume. Of the ten universities with the highest funding volumes, eight are also among the top ten with the highest per-capita funding amount. However, the ranking adjusted for staff size is also clearly led by **U Mainz**. Together with **U Regensburg**, which also has a strong concentration in the natural sciences and follows after **U Mainz** in the adjusted ranking, the university therefore ranks among the institutions with an overall profile that heavily emphasises natural sciences.

12 See also "University staff" in the Glossary of Methodological Terms at www.dfg.de/fundingatlas.

AvH-funded Visiting Researchers Prefer Universities in Munich, Bonn and Münster

The most important destinations during the reporting period for visiting researchers funded by the AvH were the Bavarian universities of **TU Munich** and **LMU Munich,** and also **U Bonn**, **U Münster** and **TH Aachen**. TH Aachen also leads the ranking for DAAD funding, with **FU Berlin** and **KIT Karlsruhe** also continuing to occupy top places (see Table Web-52 at www.dfg.de/fundingatlas).

During the reporting period, the ERC funded 82 researchers in natural sciences at German universities. 54 ERC grantees were primarily based at non-university institutions, including 31 grantees at institutions of the Max Planck Society and 14 at institutions of the Helmholtz Association (see Table 5-2).

Detailed information on the number of AvH, DAAD and ERC funding recipients per

Figure 4-9:
DFG awards for 2014 to 2016 by research field in the natural sciences

Note: Areas are proportionate to funding distribution. Figures are in millions of euros. Corresponds to Abbildung 4-12 of the DFG Förderatlas 2018.

Data basis and source:
Deutsche Forschungsgemeinschaft (DFG, German Research Foundation): DFG awards for 2014 to 2016.
Calculations by the DFG.

Table 4-10:
Participation[1)] in DFG, federal government and EU funding programmes for research by type of institution in the engineering sciences

Type of institution	DFG awards		Direct R&D project funding from the federal government		R&D funding in Horizon 2020	
	€m	%	€m	%	€m	%
Higher education institutions	**1,392.4**	**90.4**	**1,445.3**	**27.1**	**417.0**	**23.4**
Non-university research institutions	**148.7**	**9.6**	**1,431.5**	**26.8**	**531.0**	**29.8**
Fraunhofer-Gesellschaft (FhG)	20.9	1.4	560.5	10.5	195.2	10.9
Helmholtz Association (HGF)	21.3	1.4	240.3	4.5	116.1	6.5
Leibniz Association (WGL)	21.0	1.4	52.1	1.0	21.1	1.2
Max Planck Society (MPG)	31.3	2.0	24.4	0.5	22.0	1.2
Federal research institutions	6.8	0.4	40.1	0.8	9.5	0.5
Other research institutions	47.5	3.1	514.1	9.6	167.1	9.4
Industry and commercial enterprises			**2,454.7**	**46.0**	**836.5**	**46.9**
Institutions overall	**1,541.2**	**100.0**	**5,331.5**	**100.0**	**1,784.6**	**100.0**

[1)] Funding for German and institutional recipients only.

Note: Corresponds to Tabelle 4-22 of the DFG Förderatlas 2018.

Data basis and sources:
Deutsche Forschungsgemeinschaft (DFG, German Research Foundation): DFG awards for 2014 to 2016.
EU Office of the BMBF: Participation in Horizon 2020. EU Framework Programme for Research and Innovation (project data as of 28 February 2017).
Federal Ministry for Economic Affairs and Energy (BMWi): Funding for the Central Innovation Programme for SMEs (ZIM) 2014 to 2016.
Federal Ministry of Education and Research (BMBF): Direct R&D project funding by the federal government 2014 to 2016 (PROFI project database).
Calculations by the DFG.

university and non-university research institution can be found in Tables Web-27, Web-29, Web-30 and Web-31 at www.dfg.de/fundingatlas.

Physics Research Fields in the Focus of DFG Funding in the Natural Sciences

In the DFG classification system, the natural sciences are divided very finely into 18 research fields. As shown in Figure 4-9 in the form of a Voronoi diagram, a large proportion of DFG funding goes to projects in research fields relating to physics, followed by chemistry, geosciences and finally mathematics. The highest absolute amount was received for projects with a focus on condensed matter physics (€356 million), followed by mathematics (€213 million) and molecular chemistry (€156 million).

As for the previous disciplines, DFG funding in the natural sciences is represented in the form of a word cloud[13] at www.dfg.de/fundingatlas (Figure Web-9) (see section 4.3). Here too, physics and its sub-areas play an important role in the overall picture.

Detailed analyses of DFG funding profiles by university and for non-university research institutions, broken down by research area and research field as distinguished in the Voronoi diagram above, can be found in tabular form at www.dfg.de/fundingatlas (Tables Web-10 and Web-19).

4.6 Funding Profiles in the Engineering Sciences

Research in the engineering sciences is considered particularly relevant to real-life applications. This discipline benefits to a significant extent from federal government and EU programmes. At €5.3 billion, this discipline received half of the federal government's R&D project funding. A comparison with the last reporting period shows an increase of €1 billion, which is, however, primarily due to the enlargement of the data basis for federal funding through the integration of the Central Innovation Programme for SMEs (ZIM).[14]

13 See also "Word cloud" in the Glossary of Methodological Terms at www.dfg.de/fundingatlas.

14 See also "Federal funding" in the Glossary of Methodological Terms at www.dfg.de/fundingatlas.

Table 4-11:
The higher education institutions with the highest DFG awards for 2014 to 2016 in absolute figures and relative to staff size in the engineering sciences

DFG awards (absolute)		DFG awards relative to size[1]					
Higher education institution	Total	Higher education institution	Professorial staff		Higher education institution	Researchers	
	€m		N	€ thousand per prof.		N	€ thousand per res.
Aachen TH	134.3	Erlangen-Nürnberg U	99	872.5	Bielefeld U	226	75.3
Erlangen-Nürnberg U	86.4	Freiburg U	40	845.0	Freiburg U	505	67.3
Dresden TU	85.4	Aachen TH	168	799.1	Oldenburg U	132	66.5
Darmstadt TU	82.5	Bochum U	63	687.5	Erlangen-Nürnberg U	1,306	66.1
Stuttgart U	79.8	Chemnitz TU	58	676.8	Saarbrücken U	338	62.0
Karlsruhe KIT	72.2	Freiberg TU	41	672.6	Jena U	133	61.2
Munich TU	66.6	Hannover U	94	666.9	Bochum U	786	55.5
Hannover U	62.8	Darmstadt TU	146	565.4	Kiel U	311	55.0
Berlin TU	59.3	Karlsruhe KIT	131	550.6	Hannover U	1,183	53.1
Dortmund TU	44.5	Stuttgart U	151	528.8	Bremen U	568	53.0
Bochum U	43.6	Bremen U	59	514.4	Darmstadt TU	1,586	52.0
Chemnitz TU	39.3	Dresden TU	175	489.1	Ulm U	254	51.8
Freiburg U	34.0	Dortmund TU	99	449.0	Konstanz U	108	51.3
Braunschweig TU	33.0	Saarbrücken U	50	423.4	Dortmund TU	890	50.0
Bremen U	30.1	Kiel U	43	400.6	Aachen TH	3,013	44.6
Kaiserslautern TU	28.2	Jena U	21	383.8	Karlsruhe KIT	1,690	42.7
Freiberg TU	27.6	Paderborn U	48	370.1	Kaiserslautern TU	660	42.7
Duisburg-Essen U	21.6	Munich TU	184	361.0	Hamburg U	117	42.2
Hamburg TU	21.5	Bayreuth U	24	359.1	Chemnitz TU	938	41.9
Saarbrücken U	21.0	Ulm U	37	353.5	Freiberg TU	667	41.4
Ranked 1–20	**1,073.7**	**Ranked 1–20**	**1,732**	**620.0**	**Ranked 1–20**	**15,411**	**69.7**
Other HEIs[2]	**318.7**	**Other HEIs[2]**	**10,717**	**29.7**	**Other HEIs[2]**	**36,767**	**8.7**
HEIs overall	**1,392.4**	**HEIs overall**	**12,449**	**111.9**	**HEIs overall**	**52,178**	**26.7**
of which: universities	**1,382.4**	**of which: universities**	**3,664**	**377.3**	**of which: universities**	**35,837**	**38.6**
Based on: N HEIs	**127**	**Based on: N HEIs**	**221**	**119**	**Based on: N HEIs**	**230**	**119**

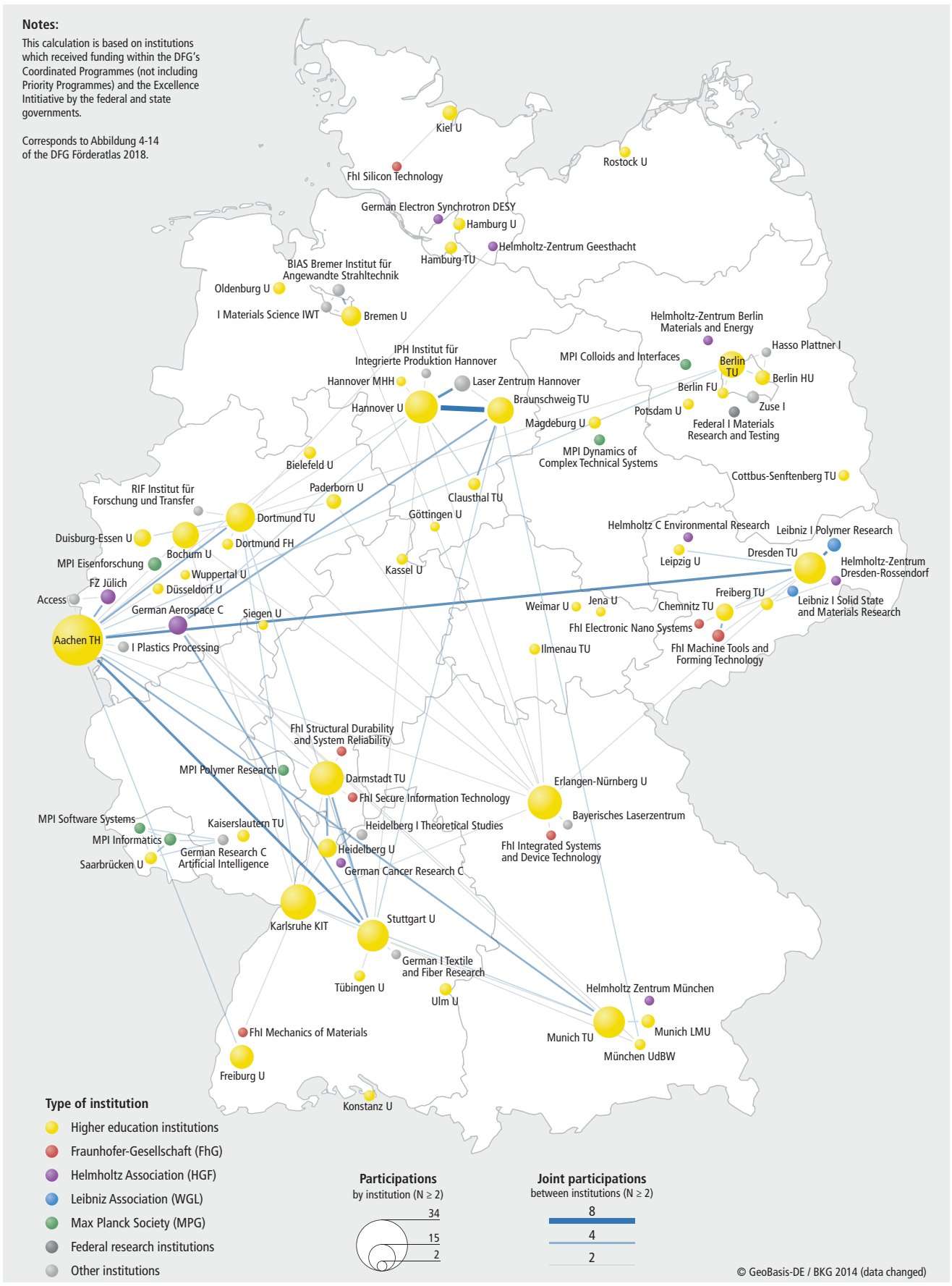
[1] Only HEIs which employed more than 20 professors or 100 or more researchers in the scientific discipline under consideration during 2015 were included within the scope of this calculation.
[2] Please see Tables Web-6 and Web-11 at www.dfg.de/fundingatlas for data on other higher education institutions.

Note: Corresponds to Tabelle 4-23 of the DFG Förderatlas 2018.

Data basis and sources:
Deutsche Forschungsgemeinschaft (DFG, German Research Foundation): DFG awards for 2014 to 2016.
Federal Statistical Office (DESTATIS): Education and Culture. Personnel at Higher Education Institutions, 2015. Special analysis of Subject-Matter Series 11, Series 4.4.
Calculations by the DFG.

Between 2014 and 2016, the DFG approved €1.5 billion for research projects in the engineering sciences. In Table 4-10, the distribution of approved funds for projects in the engineering sciences is compared for the DFG, the federal government and the EU. In the current time window, as in the reporting period 2011 to 2013, approximately 90% of DFG awards in the engineering sciences went to university-based projects (DFG, 2015a: 149). In this edition of the DFG Funding Atlas, funds awarded to industry are also broken down by discipline for the first time. For the federal government and the EU, this is clearly the largest customer group in the engineering sciences – in distinct contrast to the other three disciplines and the DFG, whose funding focuses exclusively on the public sector.

Figure 4-10:
Participations by research institutions in DFG-funded joint programmes and resulting collaborative relationships 2014 to 2016 in the engineering sciences



Distinct Networking Profile in the Engineering Sciences

Figure 4-10 shows the universities which successfully proposed an especially high number of projects in the engineering sciences in DFG Coordinated Programmes and the Excellence Initiative (see section 4.3). In contrast to the previous sections on the other three disciplines, where all networks showed a strong cluster in Berlin and (with the exception of the humanities and social sciences) also in Munich, the engineering sciences are clearly centred around a hub in the Aachen area. **TH Aachen**, **TU Dortmund**, **U Erlangen-Nürnberg** and **U Stuttgart,** as well as a number of other universities and non-university research institutions, are well networked both regionally and across the country. A close connection links **TH Aachen** with **TU Dresden,** which also performs well with respect to the engineering sciences.

TH Aachen Acquires the Most DFG Funding for Engineering Sciences in Absolute Terms – U Erlangen-Nürnberg Leads when Adjusted for Staff Size

Table 4-11 shows the 20 universities with the highest amount of DFG funding in the engineering sciences, both in absolute terms and adjusted for staff size[15]. The adjustment is based on the number of researchers and the number of professors. The highest absolute funding amount of €134 million was awarded, as in the last reporting period, to **TH Aachen**. **U Erlangen-Nürnberg**, **TU Dresden**, **TU Darmstadt** and **U Stuttgart** occupy 2nd to 5th place. Compared with the period 2011 to 2013, **U Dresden**

15 See also "University staff" in the Glossary of Methodological Terms at www.dfg.de/fundingatlas.

Figure 4-11:
DFG awards for 2014 to 2016 by research field in the engineering sciences

Note: Areas are proportionate to funding distribution. Figures are in millions of euros. Corresponds to Abbildung 4-15 of the DFG Förderatlas 2018.

Data basis and source:
Deutsche Forschungsgemeinschaft (DFG, German Research Foundation): DFG awards for 2014 to 2016.
Calculations by the DFG.

has increased its share of the funding volume by €21 million (DFG, 2015a: 152).

In relation to the number of professors, **U Erlangen-Nürnberg** acquires the highest amount of DFG funding. **U Bielefeld**, which comes in at 25th place in terms of absolute funding amount, ranks first in relation to the number of researchers. This institution, which is not generally perceived as having an engineering focus, owes this position almost exclusively to DFG-funded projects in the research field of computer science.

TU Darmstadt, TH Aachen and TU Munich Especially Attractive to AvH, DAAD and ERC Grantees

TU Munich and **TH Aachen** are especially attractive to the target group of international researchers. **TU Darmstadt** leads the ranking for AvH grantees together with **TU Munich**, while for DAAD funding recipients the leaders are Aachen and **TU Berlin** (see Table Web-57 at www.dfg.de/fundingatlas). Among ERC grantees, **TU Munich** is also very highly regarded, clearly leading the ranking in terms of the number of ERC engineering scientists working there. However, the very broad scatter in this discipline should be pointed out. A total of 34 universities were chosen by ERC grantees to carry out a project in the engineering sciences.

More detailed information on the number of AvH, DAAD and ERC funding recipients can be found in Tables Web-27, Web-29, Web-30 and Web-31 at www.dfg.de/fundingatlas.

Computer Science the Focus of DFG Funding in Engineering Sciences

Figure 4-11 shows in a Voronoi format, with proportion corresponding to area, the proportions of the awarded funding volume represented by the ten different research fields defined by the DFG within the engineering sciences. Computer science accounts for the largest share of awarded funding with just under €325 million.

This can also be seen in the word cloud[16] for the engineering sciences, available as a supplementary resource at www.dfg.de/fundingatlas (Figure Web-10). Here too, computer science emerges as a dominant subject area, both generally and in the more specialised fields of theoretical, applied and technical computer science.

Detailed analyses of DFG funding profiles by university and for non-university research institutions, broken down by research area and research field as distinguished in the Voronoi diagram above, can be found in tabular form at www.dfg.de/fundingatlas (Tables Web-11 and Web-19).

16 See also "Word cloud" in the Glossary of Methodological Terms at www.dfg.de/fundingatlas.

5 Research Funding in a European Context and Worldwide

This English edition of the DFG Funding Atlas includes a special focus on the international dimension of research. Research has always been an international endeavour. From research groups and thus communities of authors which are becoming increasingly international in their composition[1], to the fact that there are few academic conferences or congresses with participants from just a single country, and the fact that national funding providers like the DFG are increasingly drawing on international expertise to review research proposals (DFG, 2018), research thrives on international cooperation and also on international competition. National research systems benefit particularly from this competitive framework if they are open to international partnerships and if they are able to recruit outstanding researchers, in a wide range of formats, for joint research projects on a long- or short-term basis.

The following analyses illustrate various aspects of international research and funding activity which give an overall picture of the distinct international character of German research. These include the visiting researchers who come to Germany from a wide range of countries, with funding from the German Academic Exchange Service (DAAD) and the Alexander von Humboldt Foundation (AvH), to work for a set period with experts in their subject area; foreign doctoral researchers who carry out their qualifying work in DFG-funded Graduate Schools and Collaborative Research Centres with partners from all over the world; and leading researchers who have become aware, thanks to the international visibility of the Excellence Initiative, of the excellent conditions for collaborative research in Germany and are now participating in Excellence Initiative funding lines. The picture is rounded off by a special analysis of the EU programme Horizon 2020 and in particular ERC funding, both of which show how interconnected the European Research Area has already become.

The chapter introduces the topic by examining, with reference to the DFG, how an administrative framework can be created for international cooperation that helps to remove potential bureaucratic hurdles as effectively as possible in advance.

5.1 International Research Funding from the DFG

The "promotion of national and international cooperation between researchers" is one of the core objectives of the DFG, defined in its statutes. Creating good conditions for international cooperation among researchers is therefore a task that the DFG considers to be extremely important.[2]

The most important aim of the DFG's international activities is to facilitate and intensify international cooperation between researchers, scientific institutions and funding organisations. To create the best possible framework for this, the DFG enters into agreements with a wide range of partners in Europe and worldwide which establish the necessary action framework for bilaterally and multilaterally funded projects. The diversity of these agreements with international partner organisations can be seen in the overview in Table 5-1. This table shows examples of agreements with partner organisations from a variety of regions, as part of which 2016 joint projects were funded. In Table Web-36 at www.dfg.de/fundingatlas, this summary view is supplemented by additional information on the participating partner organisations.

1 See the example of chemistry in the special bibliometric analyses in the DFG Funding Atlas 2012 (DFG, 2012: 177ff.).

2 For information on the intensification of international and European cooperation at the DFG, see also DFG, 2017c: 31ff.

Table 5-1:
DFG-funding opportunities with an international component in 2016[1], listed by partner countries and type of funding

Partner countries[2]	Type of funding	Scientific disciplines
Africa (various partner countries)	Thematic call: German-African cooperation projects in infectology	Humanities and social sciences; life sciences
Argentina	Open call	Humanities and social sciences; life sciences (immunology, neurosciences); natural sciences (physical chemistry, geosciences); engineering sciences (materials science)
Brazil	Standing open calls Open call	All scientific disciplines Engineering sciences
Canada	Standing open call (for International Research Training Groups)	Natural sciences, engineering sciences
China	Thematic call: Novel Functional Materials for Sustainable Chemistry	Natural sciences (chemistry)
Colombia	Standing open call	All scientific disciplines
Czechia	Open call	All scientific disciplines
Europe (various partner countries)	ERA-Net call: BiodivERsA 3 ERA-Net call: E-RARE-3 ERA-Net call: FLAG-ERA Graphene ERA-Net call: NORFACE DIAL	Life sciences (biology/biodiversity research) Life sciences (medicine) Natural sciences (physics) Humanities and social sciences
France	Open calls	All scientific disciplines
Hungary	Standing open call	All scientific disciplines
India	Open call	Natural sciences (chemistry; physics)
Iran	Standing open call	All scientific disciplines
Israel	Standing open call Open call	All scientific disciplines All scientific disciplines
Japan	Standing open call (for International Research Training Groups)	All scientific disciplines
Luxembourg	Standing open call	All scientific disciplines
Mexico	Open call	Humanities and social sciences; life sciences (biology); natural sciences (chemistry, physics, geosciences)
Multilateral (Austria, Switzerland)	Standing open call (D-A-CH)	All scientific disciplines
Multilateral (various partner countries)	ERA-Net call: ERA-CAPS 3 Thematic call as part of the Belmont Forum: Mountains as Sentinels of Change Thematic call: T-AP (Transatlantic Platform) Digging into Data Challenge	Life sciences (molecular plant sciences) Natural sciences (geosciences); life sciences Humanities and social sciences
Poland	Open call: Beethoven 2	Humanities and social sciences; natural sciences (chemistry, physics, mathematics); engineering sciences (materials science)
Romania	Standing open call	All scientific disciplines
Russia	Open calls	All scientific disciplines
Spain	Standing open call	All scientific disciplines
South Africa	Standing open call	All scientific disciplines
South Korea	Standing open call	Life sciences; natural sciences; engineering sciences
Taiwan	Standing open call	All scientific disciplines
USA	Participation in PIRE programme Open call	Humanities and social sciences (social and behavioural sciences); life sciences (without medicine); natural sciences; engineering sciences Natural sciences (physics)
Vietnam	Standing open call	All scientific disciplines

[1] Includes all international research projects which were funded by DFG and a partner organisation on basis of a Memorandum of Understanding (MoU) and a commonly launched call, review or funding decision in 2016.
[2] A detailed overview is available in Table Web-36 at www.dfg.de/fundingatlas.

Note: Corresponds to Tabelle 3-4 of the DFG Förderatlas 2018.

Data basis and source:
Deutsche Forschungsgemeinschaft (DFG, German Research Foundation).

International research funding from the DFG enables cooperation with the most important international communities and develops cross-border models for such cooperation, on the basis of scientific needs. The DFG draws on a varied portfolio of funding formats depending on project-specific requirements and the degree of cooperation with the partner organisation. As a general rule, international projects are co-funded by a foreign partner organisation. The DFG funds the German component of the project and the partner organisation the foreign component. Under certain conditions, the DFG can also contribute to the foreign component without the participation of a partner organisation (in line with the "money follows cooperation line" principle[3]).

Broad Spectrum of Internationally Oriented Cooperation Agreements

Depending on the agreement with the international partner organisation, researchers in the countries linked by an agreement can propose joint bilateral and multilateral projects, either at any time without a special call (standing open procedures) or to a deadline as part of special international calls for proposals. Again depending on the nature of the agreement, bilateral and multilateral project funding varies from cross-disciplinary research with no specified topic to subject-specific and thematically defined research. As a general rule, the DFG endeavours to establish international collaborations in which proposals can be submitted at any time, in any subject area and on any topic. In so doing, it can flexibly accommodate any timing, budgetary or thematic requirements of foreign partner organisations. Proposals may be reviewed in parallel by the DFG and the partner organisation in line with national procedures, on an integrated basis following a jointly agreed review process, or by only one of the participating partner organisations in a lead agency process.

A particularly intensive form of cross-border research funding is the D-A-CH lead agency process. This programme allows German, Austrian and Swiss applicants to submit proposals for joint projects at any time, in any subject and on any topic to the DFG or its partner organisations, the Swiss National Science Foundation (SNF) and the Austrian Science Fund (FWF).

Proposals are reviewed by the participating partner organisation with the largest share of the project in accordance with its own procedures, and this organisation recommends whether a proposal be approved or rejected.

The funding organisation responsible for each national component of the proposal then reaches its decision on the basis of this recommendation. Funding can be awarded only if the partners reach a unanimous decision. A similar lead agency process exists between the DFG and the Fonds National de la Recherche (FNR) in Luxembourg.

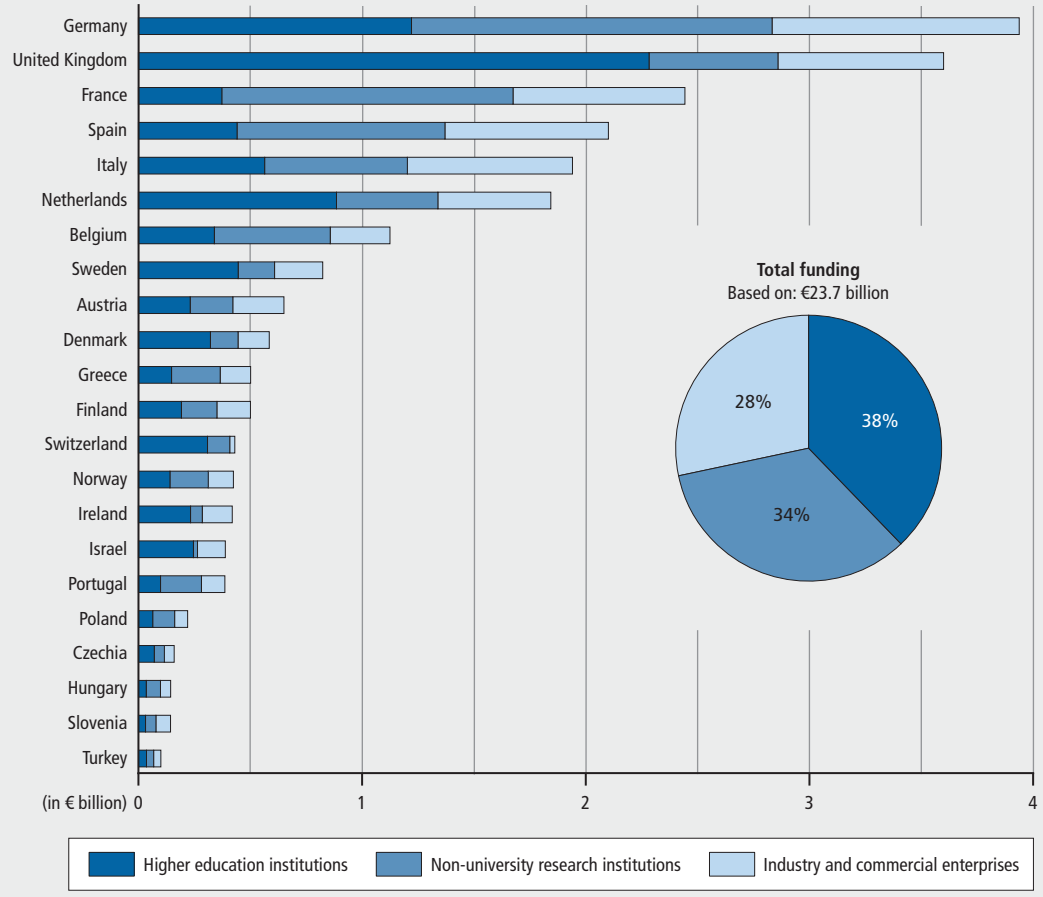
In the European Research Area, the DFG also participates in ERA-Nets, an instrument of the European Commission in which at least three participating partner organisations from countries involved in the EU Framework Programme can initiate joint calls on specific topics and receive co-funding from the Commission. In response to specific requests, the DFG also supports research projects with countries and partner organisations with which no formal agreement exists. In addition, the DFG maintains agreements with many other countries and partner organisations which are designed to promote international cooperation.

5.2 Funding in the Framework of Horizon 2020

The most recently presented analyses on the participation of German regions in the Horizon 2020 funding programmes (see section 3.4) have already shown the intensity and thematic diversity of research being conducted in these regions with the aid of EU funding. The analyses that follow add an international comparative perspective to the picture. The European Research Area is intended to be an internal area for research and innovation offering optimum support for the free movement of researchers and the free exchange of scientific knowledge and technologies (BMBF, 2016: 270). As yet it is very difficult to assess what impact the "Brexit challenge", to quote the heading in the most recent annual review of the Commission of Experts for Research and Innovation (EFI, 2018: 63), will have on international cooperation. As the analyses

3 See for example www.dfg.de/foerderung/programme/internationale_programme/antragstellung_oesterreich_schweiz.

Figure 5-1:
Funding in Horizon 2020 – EU Framework Programme for Research and Innovation 2014 to 2016 by country and type of funding recipient



Note: Corresponds to Abbildung 3-12 of the DFG Förderatlas 2018.

Data basis and source:
EU Office of the BMBF: Participation in Horizon 2020. EU Framework Programme for Research and Innovation (project data as of 28 February 2017). Calculations by the DFG.

presented below reveal, the UK plays a central role in the European research system.

In order to reach conclusions about internal European cooperation and programme participation, the following analyses focus on the EU-28 and the associated countries participating in Horizon 2020.[4]

Clear Sectoral Differences in Horizon 2020 Participation by Country

Figure 5-1 shows the extent to which the leading countries in terms of participation in Horizon 2020 obtained funding through this programme – both by country and differentiated by sector: universities, non-university institutions and industry.

Looking first at the overall participation, it is obvious that research activity in Horizon 2020 is clearly dominated by two countries, the UK and Germany. They are followed at some distance by France, Spain and Italy.

In terms of sectoral participation, a clear shift can be observed compared with the 7th Framework Programme for Research and Technological Development (DFG, 2015a: 37). Participation by universities in Horizon 2020 is lower, not only in Germany – section 3.1 reported a decline from 38% to 31% – but also overall, from 43% to 38%. The two other sectors both gained from this, increasing their activity by approximately the same amount. Non-university institutions now have a share

4 See also "EU funding" in the Glossary of Methodological Terms at www.dfg.de/fundingatlas.

of 34% (compared with 32% in the 7th Framework Programme) and industry now represents a 28% share (previously 25%).

A comparison of sectoral participation in individual countries reveals some clear differences. While in Switzerland, the UK and Israel, universities represent a proportion of over 60%, in France, Portugal and Belgium they account for between 15% and 30% in Horizon 2020. In these countries the non-university sector represents a much higher share (between 46% and 53%); in France, for example, mainly the research institutions that form part of the Centre national de la recherche scientifique (CNRS). Meanwhile, strong participation by industry can be seen in Slovenia, Italy and Austria.

The participation of the various countries in the more than 20 programme areas of Horizon 2020 is shown in Figure 5-2. The twelve programme areas with the highest funding volumes are listed separately (see Table Web-41 at www.dfg.de/fundingatlas and section 3.4 on differentiation by region in Germany).

Looking firstly at the subject- or topic-based programme areas, there is generally considerable similarity between the profiles of the large countries. Country-specific focal areas tend to emerge in smaller countries. Greece, for example, leads Austria, Belgium and Finland with a focus on projects in information and communication technologies. Slovakia and Norway represent above-average shares in food, agriculture and forestry, water research and the bioeconomy. However, the overall differences are fairly small, so no country-specific focuses can be confidently identified.

European Research Council – Major Importance to EU Funding in Associated Countries Switzerland and Israel

In this DFG Funding Atlas, for EU funding, funds awarded through the European Research Council (ERC) are shown separately for the first time (as are the other two programmes with no subject or topic specifications, the Marie Skłodowska-Curie Actions and research infrastructures). As a result, Figure 5-2 shows how much the different countries vary in terms of their success in this excellence programme. EU-associated countries Switzerland and Israel are particularly successful, with this programme area, having a share of over 50% in both countries. In absolute terms, the UK and Germany received the largest amounts from this programme area.

Figure 5-3 shows ERC participations in the form familiar from previous editions of the DFG Funding Atlas, once again separately but this time broken down into four scientific disciplines. The data is drawn from the calls from 2014 to 2016 for Starting Grants, Consolidator Grants and Advanced Grants. The division into the four scientific disciplines defined by the DFG is based on the subject-area orientation of the panels that evaluate the grants.[5]

UK and the Netherlands Have Above-average Success in ERC Grants in Humanities and Social Sciences

Considering ERC grantees by discipline, a striking picture emerges with regard to the UK and the Netherlands. In both countries, ERC awards in the humanities and social sciences are higher than in all other disciplines, while for the ERC overall they represent a share of only around 21%. In Germany, by contrast, grants in the life and natural sciences are predominant. Israel and Switzerland have an ERC profile similar to that of Germany.

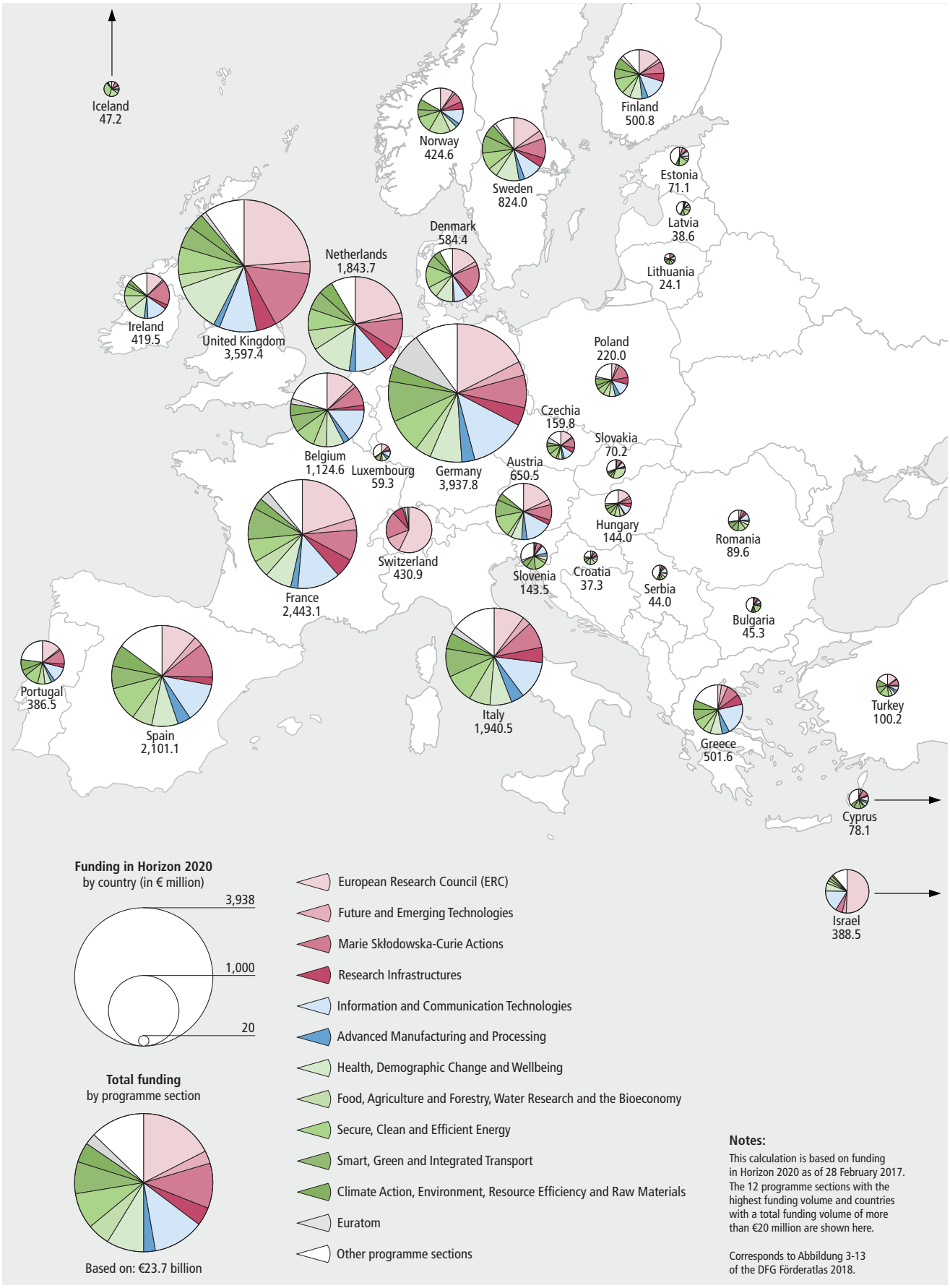
Israel – one of the Leading Research Nations and Cooperation Partners for German Researchers

The prominent position of Israel in international research has already been mentioned at various points in the Funding Atlas. Its exceptional research activity and performance have generated worldwide recognition, which is why German researchers, too, value so highly the opportunity to work with cooperation partners in this country.

In 2015, the Max Planck Society, which entered into its first cooperation agreement with an Israeli partner institution in the early 1960s, had more than 90 partnerships between German Max Planck institutes and partners in Israel. Two out of a total of 14 international Max Planck Centers are also located in Israel (MPG, no date). In September 2015, a ceremony organised by the DFG

5 See also "ERC funding" in the Glossary of Methodological Terms at www.dfg.de/fundingatlas.

Figure 5-2:
Funding in Horizon 2020 – EU Framework Programme for Research and Innovation 2014 to 2016
by country and programme section



Notes:
This calculation is based on funding in Horizon 2020 as of 28 February 2017. The 12 programme sections with the highest funding volume and countries with a total funding volume of more than €20 million are shown here.

Corresponds to Abbildung 3-13 of the DFG Förderatlas 2018.

Figure 5-3:
ERC-funded researchers 2014 to 2016 by country of destination and scientific discipline

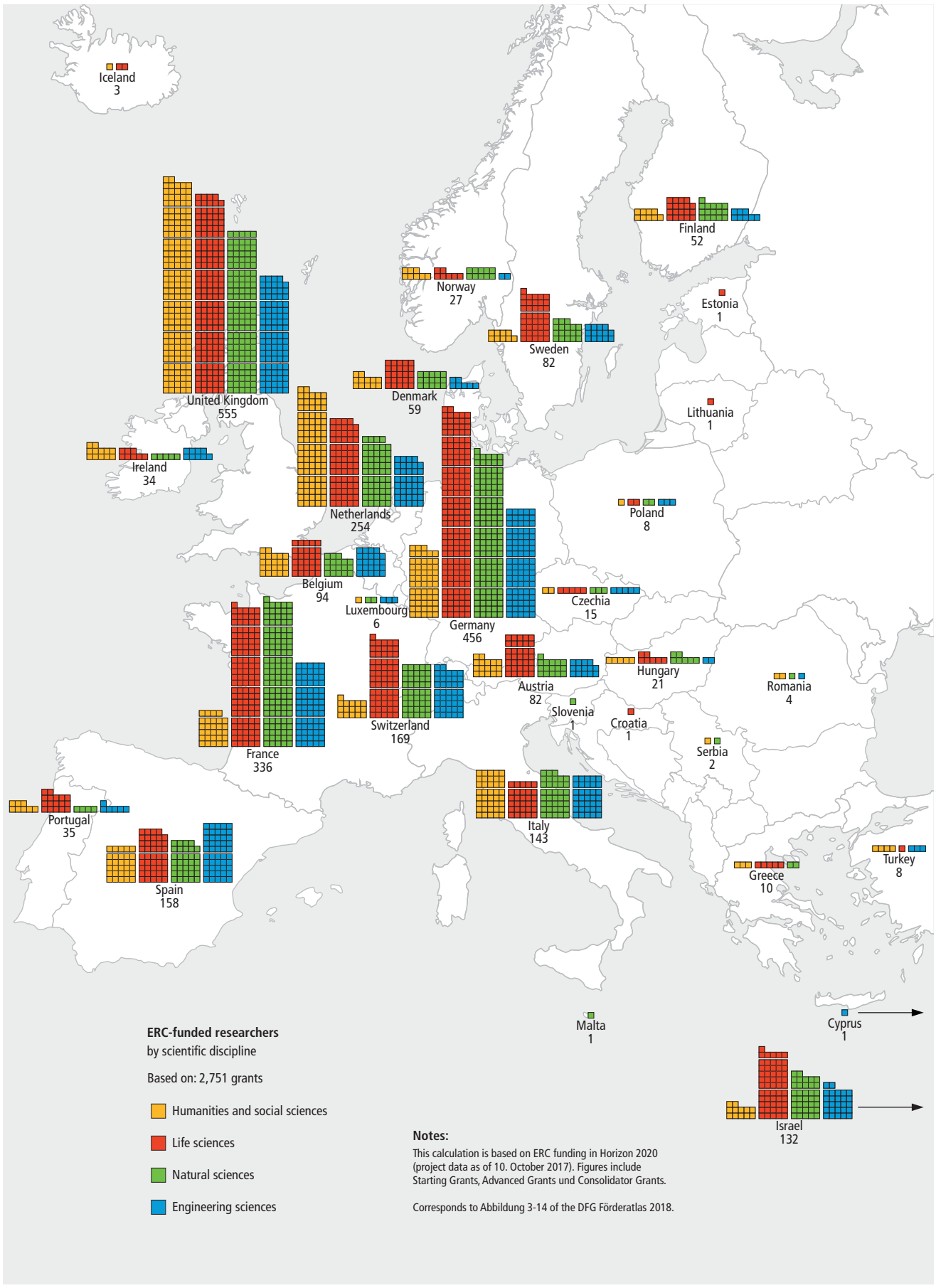


Table 5-2:
ERC funding recipients 2014 to 2016 by type of institution and scientific discipline

Type of institution	Total	Humanities and social sciences	Life sciences	Natural sciences	Engineering sciences
	N	N	N	N	N
Higher education institutions	**297**	**50**	**90**	**82**	**75**
Non-university research institutions	**159**	**8**	**82**	**54**	**15**
Fraunhofer-Gesellschaft (FhG)	1				1
Helmholtz Association (HGF)	44		28	14	2
Leibniz Association (WGL)	12	1	1	5	5
Max Planck Society (MPG)	84	5	41	31	7
Other research institutions	18	2	12	4	
Overall	**456**	**58**	**172**	**136**	**90**

Note: Corresponds to Tabelle 3-5 of the DFG Förderatlas 2018.

Data basis and source:
EU Office of the BMBF: ERC funding in Horizon 2020. EU Framework Programme for Research and Innovation (project data as of 10 October 2017).
Figures include Starting Grants, Advanced Grants and Consolidator Grants.
Calculations by the DFG.

to mark the 50th anniversary of German-Israeli diplomatic relations celebrated the fact that the early commencement of scientific cooperation between Germany and Israel played a vital role in cementing the relationship between the two countries (DFG, 2015b).

German Universities and the Max Planck Society are Very Successful in ERC Funding

Germany has the largest number of ERC grantees after the UK. Their distribution by type of institution and discipline is shown in Table 5-2. As can be seen in the table, 65% of ERC grantees are employed by universities. Among non-university institutions, the Max Planck Society is particularly visible with a share of 18%. In the distribution by discipline, among non-university institutions ERC grantees in life sciences and natural sciences subjects are clearly dominant. More than 85% of all non-university-based ERC grantees work in these two disciplines.

In the case of universities, by contrast, the humanities and social sciences and the engineering sciences are also proportionally well represented at 17% and 25%. The most popular universities chosen by ERC grantees in Germany can be seen in Table 5-3.

ERC Grantees Prefer Munich Universities – U Cologne Enters Top 5

As in the analysis of the ERC grants awarded in the 7th Framework Programme for Research and Technological Development (DFG, 2015a: 67), the two Munich universities **LMU Munich** and **TU Munich** lead the ranking, each accounting for (almost) twice as many ERC grantees as the next highest institutions, **U Freiburg** and **U Heidelberg**. **U Cologne** has significantly improved its position. Throughout the 7th Framework Programme (2007 to 2013) just seven ERC grantees researched at **U Cologne**, but for Horizon 2020, launched in 2014, the figure is 13, nearly doubling the number of leading researchers opting for this location. Table Web-27 at www.dfg.de/fundingatlas provides an overview of other universities chosen by ERC grantees in Germany, differentiated by discipline.

5.3 Networking within the European Research Area as Part of Horizon 2020

Since its beginnings, EU funding has focused on international cooperation. This is reflected for example in the requirement that a call within Horizon 2020 normally requires a minimum number of institutional partners. This usually means three partners from different countries, with no specific requirements

as to the geographical distribution of the partners. The 2003 edition of the DFG Funding Atlas reporting series used this as an opportunity to visualise the relationships resulting from participations in the 5th Framework Programme as a network diagram (DFG, 2003: 108). This special focus section of the DFG Funding Atlas updates the analysis to reflect current data and presents it in a new format.

The analysis is based on information on nearly 14,000 contracts associated with close to 58,000 participations in the relevant funded projects.[6] A participation always relates to an institutional partner, regardless of how many persons are involved in the project at this partner institution. The project coordinator plays a special role within a consortium. In addition to scientific expertise relevant to the project, the role of project coordinator normally requires experience in leading major, cross-border research projects. Special attention is therefore given to this role in the analysis that follows.

Figure 5-4 shows, in the format of a map of Europe, the extent to which the various countries are involved in international cooperation networks and which countries have particularly close relationships – as indicated by the thickness of the connecting lines between them. The underlying data on 58,000 participations is corrected for multiple participations for each country and project, so a total of around 36,000 country-specific participations are taken into account. All countries with at least 200 project participations are shown. The diagram visually emphasises the proportions with which universities and research institutions in the various countries play a coordinating leadership role in Horizon 2020-funded projects.

Table 5-3:
The most frequently selected host universities by ERC-funded researchers 2014 to 2016

Host institution	Number of recipients
	N
Munich LMU	28
Munich TU	27
Freiburg U	14
Heidelberg U	14
Cologne U	13
Göttingen U	12
Dresden TU	11
Bochum U	10
Berlin FU	8
Bonn U	8
Erlangen-Nürnberg U	8
Tübingen U	8
Würzburg U	8
Aachen TH	7
Darmstadt TU	7
Hamburg U	7
Berlin HU	6
Bremen U	6
Münster U	6
Frankfurt/Main U	5
Karlsruhe KIT	5
Leipzig U	5
Ranked 1–20	**223**
Other HEIs[1)]	**74**
HEIs overall	**297**
Based on: N HEIs	**56**

[1)] Please see Table Web-27 at www.dfg.de/fundingatlas for data on other higher education institutions.

Note: Corresponds to Tabelle 3-6 of the DFG Förderatlas 2018.

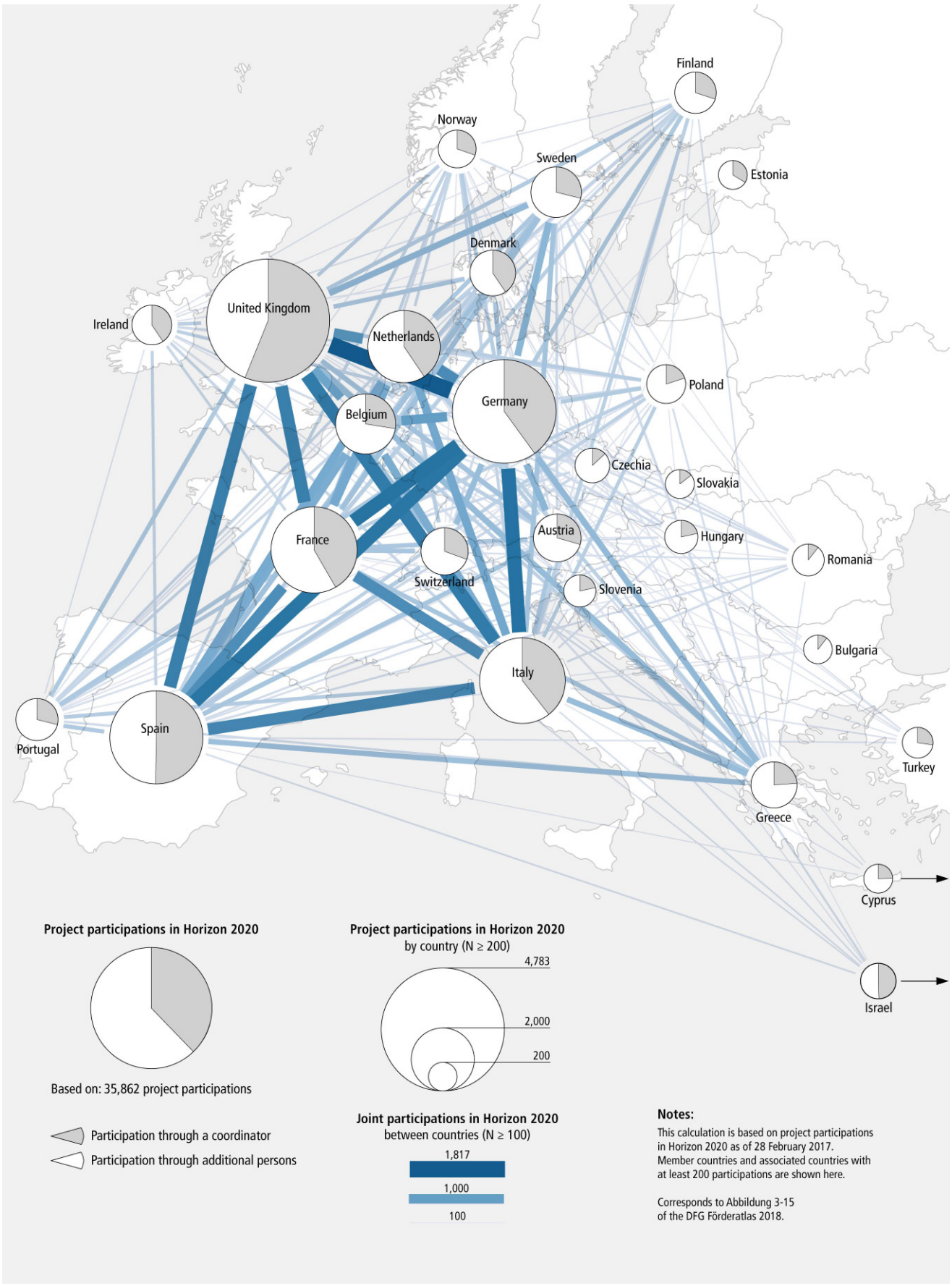
Data basis and source:
EU Office of the BMBF: ERC funding in Horizon 2020. EU Framework Programme for Research and Innovation (project data as of 10 October 2017). Figures include Starting Grants, Advanced Grants and Consolidator Grants.
Calculations by the DFG.

UK Has Significantly Above-average Participation as Coordinator in Horizon 2020 Projects

Looking firstly at project coordination, there are clear differences between the various countries. As a general average, the proportion of projects for which an institution in a given country acts as project coordinator is around 25%. Large and long-term EU member states, in particular, tend to have much higher values. The leading countries in this respect also include Israel, a non-EU member but long-term associated partner in the EU Framework Programmes with a share of close to 50%. The UK has the highest share of project coordinator roles at 56%. Researchers in this country therefore serve as project coordinators to a clearly above-average degree. The only similarly high value is that for Spain, which like Israel accounts for around 50% of project coordination roles.

6 See also "EU funding" in the Glossary of Methodological Terms at www.dfg.de/fundingatlas.

Figure 5-4:
Participations in Horizon 2020 – EU Framework Programme for Research and Innovation 2014 to 2016 and resulting collaborative relationships between countries in Europe



By contrast, countries in eastern Europe (still) perform this type of leadership role comparatively rarely. Estonia stands out with a share of around 34%.

As would be expected, the number of project participations (represented by the diameter of the circle for each country) is distributed very similarly to the funding amounts in Figure 5-2. Germany has approximately 3,800 country-specific project participations; the value for the UK is around one quarter higher at 4,800 participations. They are followed by Spain, France and Italy with approximately 3,000 project participations each. In total, 128 countries have project participations in Horizon 2020, of which 43 are either EU member states or associated countries in Horizon 2020.

Figure 5-4 shows 27 countries with more than 200 project participations.

Germany and UK Most Frequent Partner Countries in Horizon 2020 Projects

Turning finally to relationships between countries, the partnership between the UK and Germany is particularly intensive. This corresponds to the finding in the DFG Funding Atlas 2003. There are also strong relationships between Spain, France and Italy – both with each other and with Germany or the UK. This core network of Horizon 2020 is completed, though with slightly weaker links, by the Netherlands.

The leading role played by Germany and the UK in Horizon 2020-funded research is also illustrated by the following figures. For 33 of the 43 countries, one of these two countries is the most frequent partner country in an EU project. If the second most frequent partner is included, Germany and/or the UK are the most frequent or second most frequent partner in 40 out of 43 cases.

Detailed Analyses for Selected German Universities in Online Material

Complementing the view shown here focusing on relationships between countries, the online material accompanying the DFG Funding Atlas at dfg.de/fundingatlas includes analyses showing with which countries German universities cooperate most frequently as part of Horizon 2020. The most frequent partner countries for a selection of around 80 universities are shown in the form of a ring diagram. This representation complements the university views presented in the DFG Funding Atlas 2015, which show the key figures in the DFG Funding Atlas for the selected universities at a glance and also allows universities to integrate them into their own websites.

5.4 National and International Mobility in Research

Active researchers tend to be highly mobile. Research visits to various institutions, whether long or short in duration, often international, contribute to the development of their academic profiles and professional networks. Researcher mobility in Europe provides the thematic focus for the following analysis. Mobility within Germany at early career stages and global migration movements will also be considered. To illuminate the issue from different angles, multiple data sources were used.

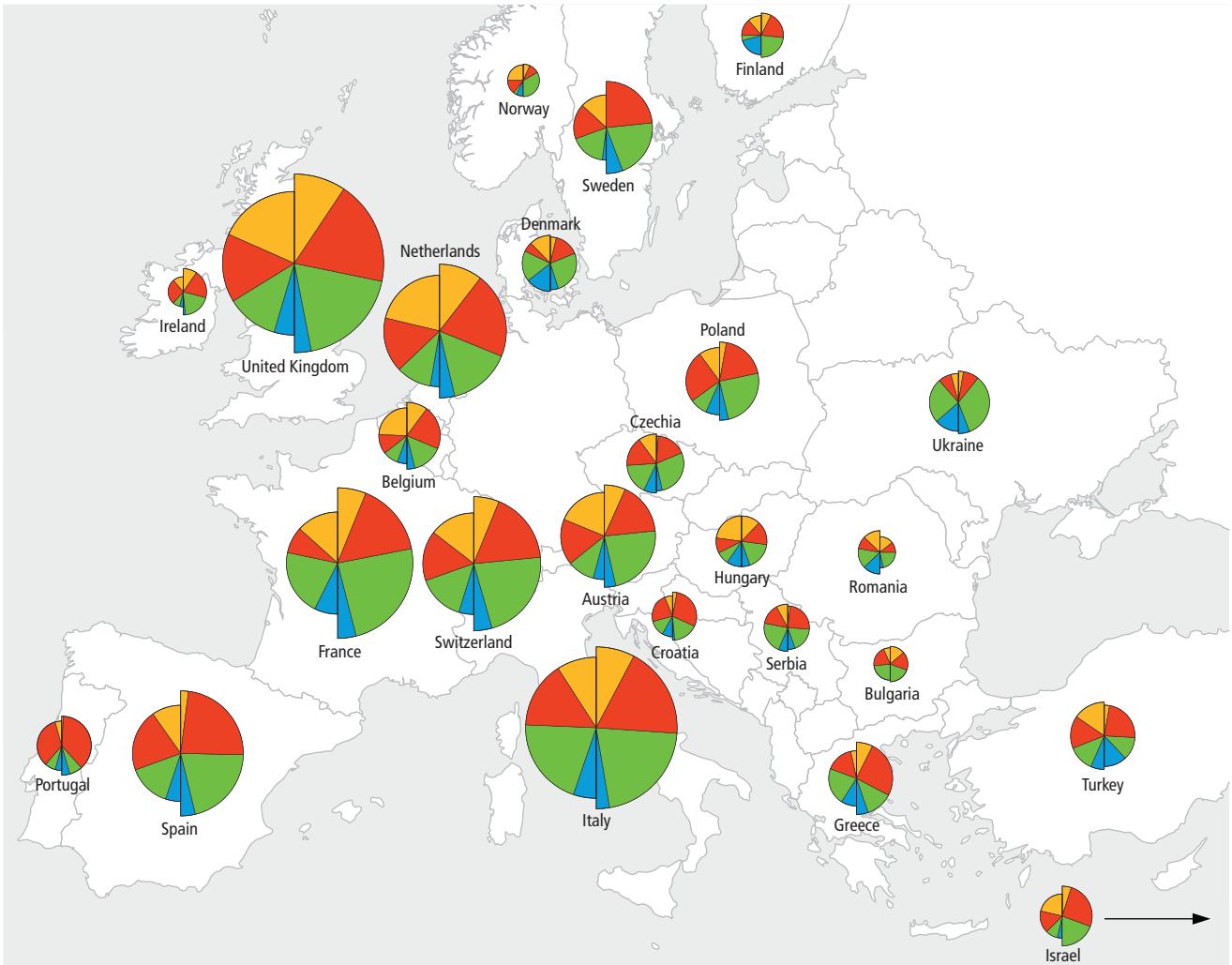
Around 1 in 5 People Involved in DFG-funded Groups Previously Worked Abroad

The first analysis of researcher mobility relates to data on research staff in Collaborative Research Centres, Research Training Groups and the Graduate Schools and Clusters of Excellence in the Excellence Initiative. For these funding instruments, the DFG conducts annual surveys of around 50,000 individuals at all career levels (from doctoral and postdoctoral to professor), who determine the scientific programme within the various groups.[7]

These surveys demonstrate that around 20% of individuals surveyed in 2016 had worked at a research institution abroad prior to their involvement in a research group. There are slight differences between the funding instruments: while for Excellence Initiative programmes, i.e. Clusters of Excellence and Graduate Schools, the propor-

7 See also "DFG annual survey" in the Glossary of Methodological Terms at www.dfg.de/fundingatlas and www.dfg.de/en/dfg_profile/facts_figures/evaluation_studies_monitoring/surveys.

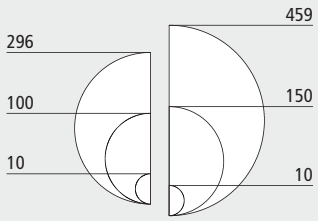
Figure 5-5:
Countries of origin of researchers participating in Graduate Schools, Research Training Groups, Clusters of Excellence and Collaborative Research Centres 2016



Participants by country of origin

Graduate Schools and Research Training Groups

Clusters of Excellence and Collaborative Research Centres



- Humanities and social sciences
- Life sciences
- Natural sciences
- Engineering sciences

Notes:

This calculation is based on the countries of origin of researchers prior to participation in Graduate Schools (2,572), Research Training Groups (1,229), Clusters of Excellence (2,715) and Collaborative Research Centres (2,785) from the DFG monitoring 2016. Countries with 20 or more persons are shown here.

Corresponds to Abbildung 3-16 of the DFG Förderatlas 2018.

Participants from other countries of origin

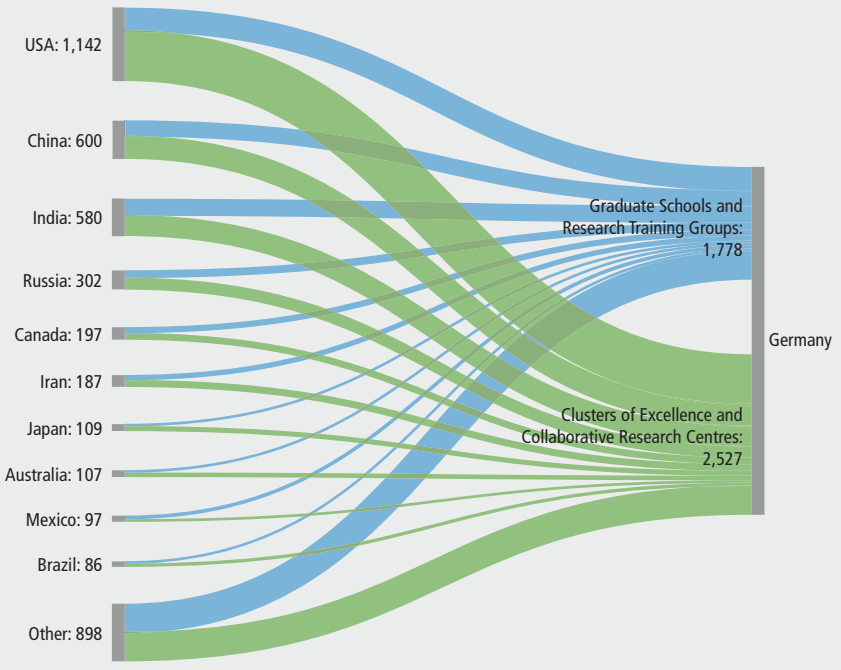
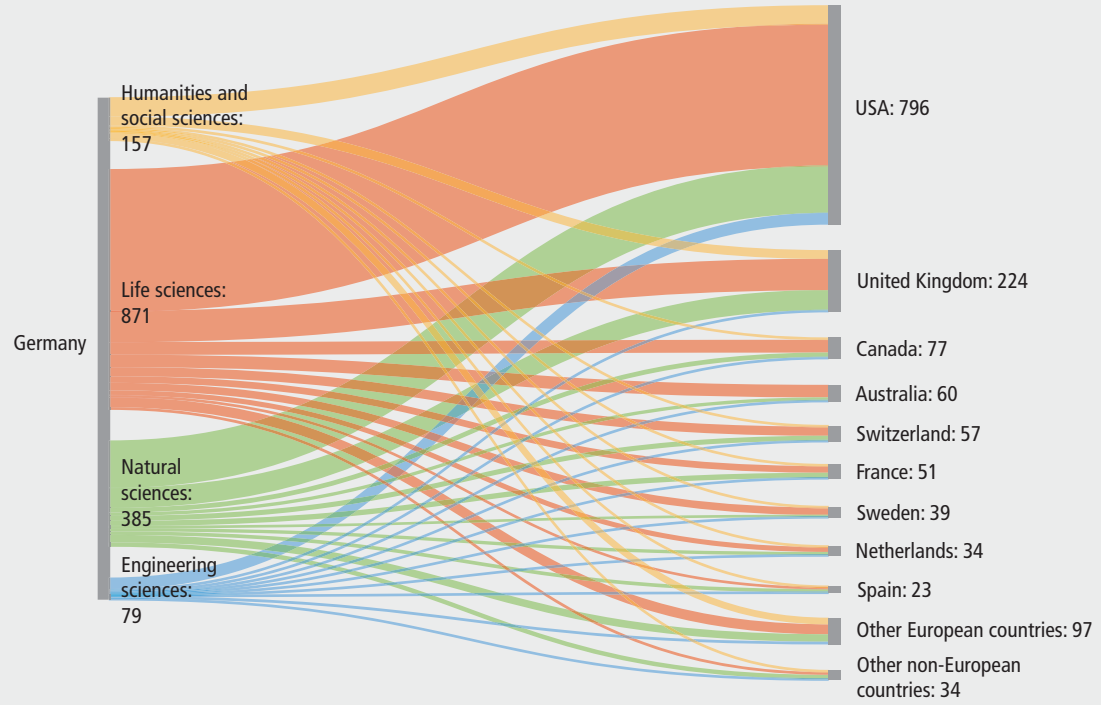


Figure 5-6:
Destinations for DFG research fellowships from 2014 to 2016 by scientific discipline



Note: Corresponds to Abbildung 3-17 of the DFG Förderatlas 2018.

Data basis and source:
Deutsche Forschungsgemeinschaft (DFG, German Research Foundation): DFG awards for 2014 to 2016.
Calculations by the DFG.

tion of researchers previously active abroad is 28%, the figure for Collaborative Research Centres and Research Training Groups is lower at around 15%. The attention that Germany's Excellence Initiative has attracted around the world is clearly reflected in this international recruitment success.

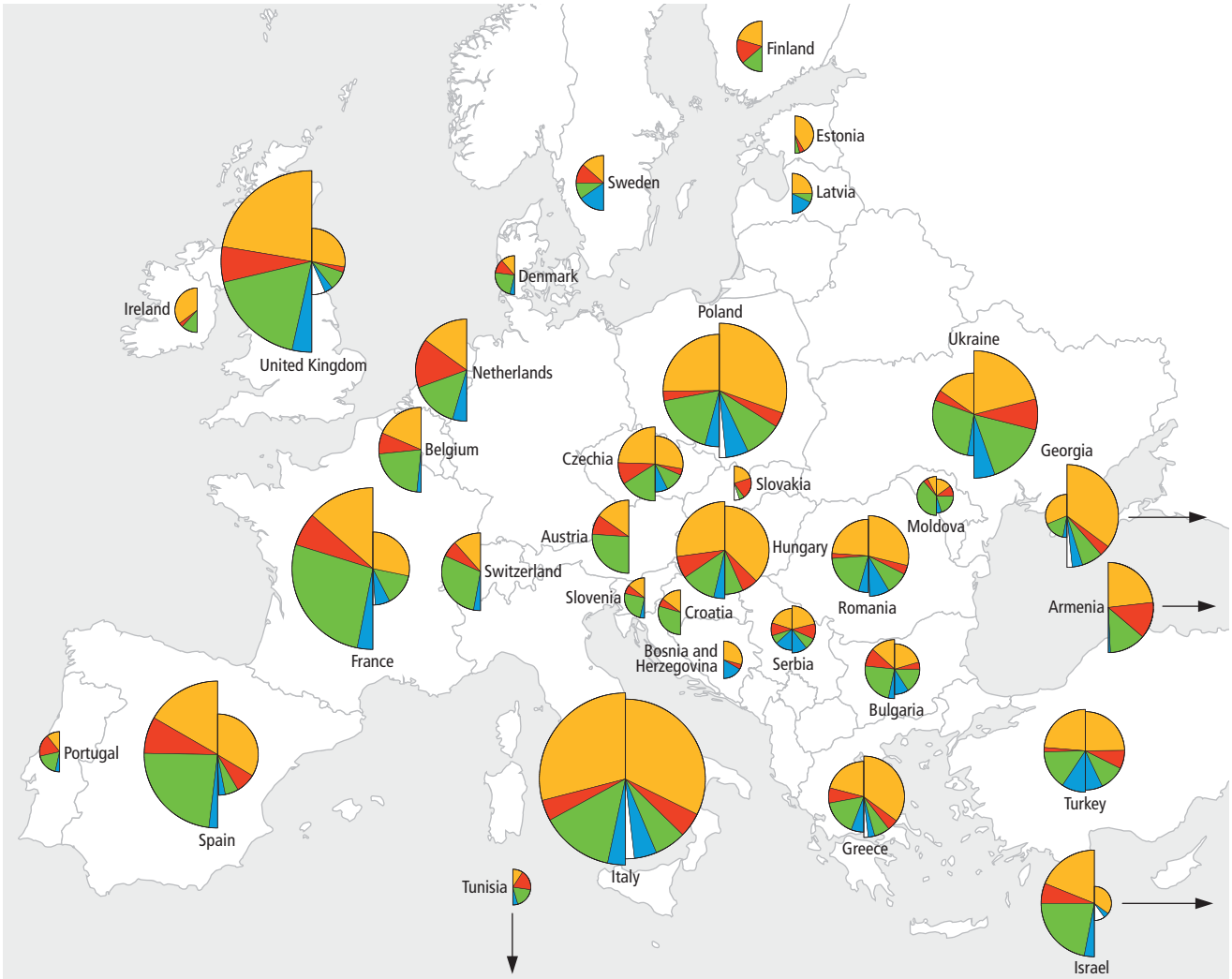
USA Most Frequent Country of Origin for Persons Involved in DFG Research Groups

Graduate Schools and Research Training Groups, which are primarily designed to support doctoral researchers, are shown in Figure 5-5 along with Collaborative Research Centres and Clusters of Excellence, which are focused on the promotion of top-level research. The size of the two semicircles corresponds to the number of persons, differentiated by discipline. The most frequent country of origin in Europe is the UK, followed by Italy. Outside Europe, it is the USA, followed by India for Graduate Schools and Research Training Groups and by China for Collaborative Research Centres and Clusters of Excellence.

Overall, the diagram clearly demonstrates that Clusters of Excellence and Collaborative Research Centres more often recruit researchers from western European countries such as Spain, France, Switzerland, the UK, the Netherlands, Italy and Austria, while groups with a greater focus on supporting doctoral researchers recruit proportionally more often from Turkey, Serbia, Czechia and Romania.

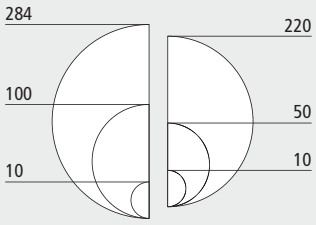
Data on the destinations of DFG-funded research fellows provides another perspective on mobility (see Figure 5-6). The target group for research fellowships is early career researchers, for whom the fellowship is intended to provide an opportunity, after completing a doctorate, to carry out a research project at the location of their choice abroad in order to familiarise themselves with new research methods and/or complete a larger project. In the period from 2014 to 2016, approximately 1,500 fellowships were awarded.

Figure 5-7:
AvH- and DAAD-funded researchers 2012 to 2016 by country of origin and scientific discipline



Funding recipients by country of origin

AvH funding recipients DAAD funding recipients



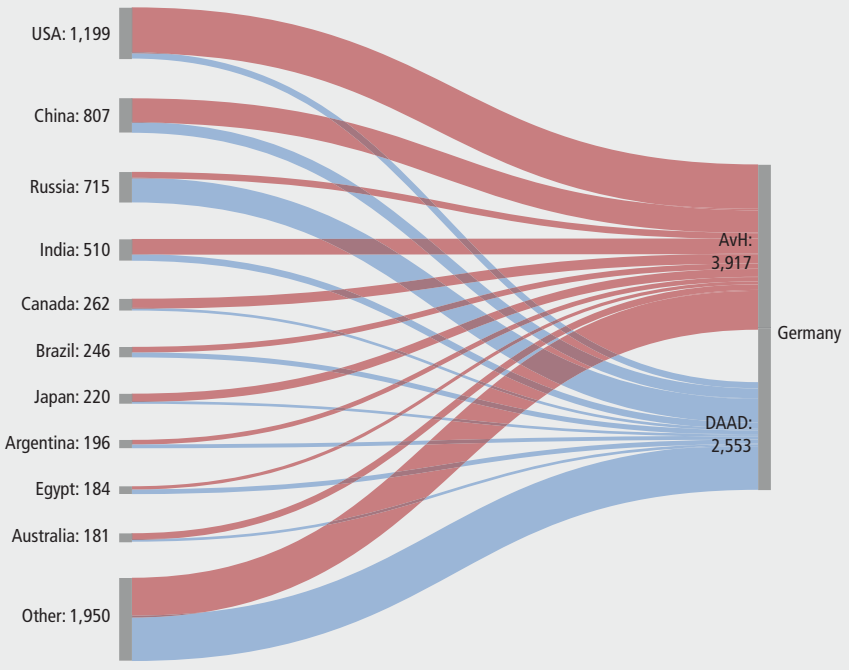
- Humanities and social sciences
- Life sciences
- Natural sciences
- Engineering sciences
- Classification not possible

Notes:

Calculations are based on the countries of origin of researchers from 5,901 AvH-funded and 4,065 DAAD-funded research visits to Germany from 2012 to 2016. Countries with 10 or more AvH or DAAD funding recipients are shown here.

Corresponds to Abbildung 3-18 of the DFG Förderatlas 2018.

Funding recipients from other countries of origin



USA an Important Destination for DFG-funded Research Fellows

The most frequent country of origin for researchers participating in DFG Coordinated Programmes and the Excellence Initiative, the USA, is also the most important destination for DFG research fellowships. It is followed at some distance by the UK. The second most frequent non-European country of origin is Canada. All the countries mentioned have highly developed research systems. This corresponds with the objective of giving funding recipients the opportunity to deepen their knowledge by working in outstanding research locations. This funding instrument is most frequently used in the life sciences.

Clear Correspondence in Mobility for Selected DFG Funding Instruments and AvH and DAAD Funding Recipients

A third source of mobility analyses, already familiar from previous editions of the DFG Funding Atlas, is data on the national origin of AvH- and DAAD-funded researchers (see Figure 5-7).[8]

Here too, the patterns that emerge are comparable to previous findings. When the AvH and DAAD are considered together, the most important European countries of origin are Italy, the UK, France and Poland, and outside Europe, the USA, China, Russia and at some distance India.

Clear Differences in Countries of Origin of AvH- and DAAD-funded Visiting Researchers

The countries of origin of AvH and DAAD funding recipients vary considerably, revealing different funding focuses between the two organisations.

Within Europe, AvH-funded researchers frequently come from western and northern European neighbouring countries – for example the Netherlands, Switzerland, Sweden and Finland – while DAAD funding recipients frequently originate from eastern European countries such as the Baltic states of Estonia and Latvia, Ukraine, Georgia and Armenia. Many central European countries are represented roughly equally between both funding providers, for example Poland, Czechia, Hungary and Romania.

For non-European countries there are also clear differences between the two organisations. While the USA, China and India are prominent countries of origin for the AvH, for the DAAD it is mainly Russia and many smaller countries (for example Uzbekistan, Iran, South Korea and Mexico), which are brought together under "Other" in the diagram due to the small numbers involved. Comprehensive information on international mobility can be found in the annual reporting system Wissenschaft weltoffen (DAAD, DZHW, 2017), which is supported by BMBF funds. This resource, supervised by the German Academic Exchange Service and complemented by varied online material, reports in detail on the international dimension of study and research in Germany. The DAAD website also features a scholarship database for foreign students, graduates and researchers which contains numerous scholarship offers for study or teaching visits and research projects in Germany.[9]

8 See also "AvH funding" and "DAAD funding" in the Glossary of Methodological Terms at www.dfg.de/fundingatlas.

9 www.daad.de/deutschland/stipendium/en

6 Appendix

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Index of Abbreviations

General Abbreviations

% cumul.	Cumulative percent
bn	Billion
BW	Baden-Württemberg
CH	Switzerland
DE	Germany
ERA	European Research Area
EXC	Cluster of Excellence
ExStra	Excellence Strategy
GDP	Gross domestic product
GEPRIS	German Project Information System
GSC	Graduate School
HEI	Higher education institution
I	Institute
IGF	Industrial Collective Research
MSCA	Marie-Skłodowska-Curie-Actions
PFI	Joint Initiative for Research and Innovation
PI	Principal investigator
prof.	Professor
PROFI	Project-funding information system of the federal government
R&D	Research and development
res.	Researcher
SME	Small and medium-sized enterprises
TU/TH	Technical University
U	University
UK	United Kingdom
USA	United States of America
ZIM	Central Innovation Programme for SME

Institutions and Organisations

AiF	German Federation of Industrial Research Associations
AvH	Alexander von Humboldt Foundation
BBSR	Federal Institute for Research on Building, Urban Affairs and Spatial Development
BKG	Federal Agency for Cartography and Geodesy
BMBF	Federal Ministry of Education and Research
BMEL	Federal Ministry of Food and Agriculture
BMUB	Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety
BMVI	Federal Ministry of Transport and Digital Infrastructure
BMWi	Federal Ministry for Economic Affairs and Energy
BMZ	Federal Ministry for Economic Cooperation and Development
CNRS	Centre national de la recherche scientifique
DAAD	German Academic Exchange Service
DESTATIS	Federal Statistical Office
DFG	Deutsche Forschungsgemeinschaft (German Research Foundation)
DLR	German Aerospace Center
EFI	Commission of Experts for Research and Innovation
ERC	European Research Council
EU	European Union
FH	University of applied sciences
FhG	Fraunhofer-Gesellschaft
FhI	Fraunhofer Institute
GWK	Joint Science Conference
HGF	Helmholtz Association of National Research Centres
HRK	German Rectors' Conference
IIT	Institute for Innovation and Technology
MPG	Max Planck Society
MPI	Max Planck Institute
OECD	Organisation for Economic Co-operation and Development
WGL	Gottfried Wilhelm Leibniz Association of Science
WR	German Council of Science and Humanities

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