ERID-Watch

European Research Infrastructure Development Watch

Work Package 1

Deliverable D3

Annexes

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2 Glossary

- **EIROForum:** A partnership of Europe's seven largest intergovernmental research organisations, which are:
  - *CERN - European Organization for Nuclear Research*
  - *EFDA - European Fusion Development Agreement*
  - *EMBL - European Molecular Biology Laboratory*
  - *ESA - European Space Agency*
  - *ESO - European Organisation for Astronomical Research in the Southern Hemisphere*
  - *ESRF - European Synchrotron Radiation Facility*
  - *ILL - Institute Laue Langevin*
- **ERA:** European Research Area - In 2000, the EU decided to create the ERA. This means creating a unified area all across Europe, in which one should:
  - *Enable researchers to move and interact seamlessly, benefit from world-class infrastructures and work with excellent networks of research institutions;*
  - *Share, teach, value and use knowledge effectively for social, business and policy purposes;*
  - *Optimise and open European, national and regional research programmes in order to support the best research throughout Europe and coordinate these programmes to address major challenges together;*
  - *Develop strong links with partners around the world so that Europe benefits from the worldwide progress of knowledge, contributes to global development and takes a leading role in international initiatives to solve global issues.*
  - *Inspire the best talents to enter research careers in Europe, incite industry to invest more in European research – contributing to the EU objective to devote 3% of GDP for research, and strongly contribute to the creation of sustainable growth and jobs.*
- **ERF:** European Association of National Research Facilities, of which the initiating associates are :
  - *Societe Civile Synchrotron Soleil (FR),*
  - *Gesellschaft für Schwerionenforschung GSI (DE),*
  - *Elettra – Societa Sincrotrone Trieste (IT),*
  - *Deutsches Elektronen-Synchrotron DESY (DE),*
  - *MAX-Lab Lund University (SE),*
  - *Grand Accelerateur National d'Ions Lourds GANIL (FR),*
  - *Paul Scherrer Institut PSI (CH),*
  - *FOM-Institute for Plasma Physics Rijnhuizen (NL),*
  - *Max-Born-Institut MBI (DE),*
  - *Hahn-Meitner-Institut HMI (DE),*
  - *Science and Technology facilities Council STFC (UK)*
- **EU 15:** Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxemburg, Nertherlands, Portugal, Spain, Sweden, United Kingdom.

- **EU 12:** Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, Slovenia.
- **FTE:** Full Time Equivalent
- **IP:** Intellectual Property
- **K&TT:** Knowledge and Technology Transfer
- **PG:** Pilot Group
- **RI:** Research Infrastructure
- **WP:** Work Package

Abbreviations of Scientific Domains

- **AANP**: Astronomy, Astrophysics, Nuclear & Particle Physics
- **BLS**: Biomedical & Life Sciences
- **CDT**: Computation and Data Treatment
- **EN**: Energy
- **ES**: Environmental Sciences
- **MS**: Material Sciences
- **SSH** : Social sciences and Humanities

3 Framework of the Study

3.1 Background and Objectives

The main purpose of the ERID-Watch project is to assess the efficiency of Research Infrastructures in Europe, their performance in terms of scientific exchange and public-private transfer and to contribute to an increase of public investment efficiency for European Research Infrastructures by benchmarking and the extraction of best practise examples. This approach includes the exchange of experiences and policies in existing Research Infrastructures. The extent to which Research Infrastructures are open not only for scientific but also for industrial communities was examined, as the basic necessity of the knowledge-based development of the modern European Society follows from this openness. Due to their unique opportunities, RIs play an important role in this process. European RIs were invited to take part in ERID-Watch by sharing their good and bad experiences. This study was conducted on a strictly voluntary basis.

Work Package 1 (WP1) of this study is devoted to identifying and benchmarking “Good Practices” within the daily work of a Research Infrastructure, for example in the areas of Technology Transfer, Human Resources and Legal Environment. To do so, a broad and deep insight into the RI landscape is needed. WP1 tried to develop this insight through extensive face to face interviews with RI representatives. During these interviews, several key pieces of information were gathered. Since the European RI landscape is very diverse – ranging from seagoing and polar Research Platforms to Synchrotrons to large Databases in different scientific domains - not all questions were applicable to all RIs. This explains why a true benchmarking analysis with an absolute ranking, which would have required complete information about all infrastructures, turned out to be infeasible. Nonetheless, this report tries to draw a thorough picture of a major part of the European Research Infrastructure landscape. Due to the time factor, 53 RIs from 16 European countries were interviewed; therefore, the report cannot be seen as a fully representative study of all RIs in Europe. But as stated before, this is not the aim – the objective of this project is to show best practices in several areas.

In addition to the face to face interviews, two further tools were used to acquire data. First, an in-depth Case Study regarding industrial usage of synchrotrons was undertaken to provide a deeper level of data in one specific field. And secondly, online web questionnaires were developed in an attempt to gather a broader array of responses from a larger number of European RIs.

It is important to keep in mind that this report is focused on Research Infrastructures, not on the institutions which host the infrastructures.

3.2 Introduction

Overall, the number of Research Infrastructures (RIs) in Europe is assumed to be at least 600 (small, medium and large). For ERID-Watch, 51 of these RIs from 16 countries of the European Research Area (ERA) were interviewed. Additionally, one RI from the United States was interviewed for comparison purposes within the Synchrotron Case Study, and special interviews for this study were also conducted with 2 additional Synchrotrons in Europe. So ultimately, 53 European RIs and one US RI have been interviewed in the course of this study.

The report cannot be seen as fully representative, but this is not the aim of the project. The aim is to show best practice experiences in several areas of RI which are important for the cooperation between RIs and industry – such as Technology Transfer (TT), Human Resources (HR), legal environment and general information. The interviewed RIs were very multifaceted in their scientific domains, their markets (scientific users or industrial users) and ways of organising themselves. This makes it impossible to compare the key figures extensively in detail, so no explicit benchmarking is possible.

Even if the project is called "European Research Infrastructure Development Watch," not all information could be gathered at the RI level, as it became apparent during the interviews that some information as well as the organisation of TT and HR are maintained on an institutional level. Also, it should be kept in mind that RIs are seldom built to simultaneously serve two markets that have different demands: the market of industrial users as well as the market of scientific users.

As stated before, the main purpose of the ERID-Watch project is to assess and evaluate the efficiency and market impact of Research Infrastructures in Europe, their performance in terms of scientific exchange, public-private transfer as well as market supply and demand and, additionally, to contribute to an increase of public investment efficiency for European Research Infrastructures via the extraction of best practise examples. Before talking about "market" or the "market demand" or "market orientation," the terms have to be defined.

Basically, Research Infrastructures' market of users is divided into two parts – the scientific market and the industrial market. It cannot be said that the RIs are not market oriented; rather, one could say that both markets seem to have different demands and most of the interviewed RIs' core focus is on the scientific market rather than on the industrial market. Their market orientation lies within the scientific community, where the demands are more focused on such features as the uniqueness of the RIs and not on industry-favoured features such as 24-hour service, for example. Up until now, both markets could not be put together and served at one time with the same means. This may explain why it is relatively seldom that an RI has equal numbers of industrial and scientific users; it is much more likely that RIs mainly serve only one of these markets.

3.3 Methodology

The WP1 Final Benchmarking Report is based on information which was gathered mainly during face to face interviews with several representatives from different Research Infrastructures. Basically, the report is based on two parts: 1) General face to face interviews with RI representatives, and 2) Interviews with Synchrotron representatives.

For the sample of interviewed RIs, the clear European dimension combined with the number of external users was relevant for choosing the RIs. Other criteria were the type, the country and the scientific domain of the RI. All EIROFORUM and ERF members were interviewed.
For the interviews during the field work, two documents, a Pre-Questionnaire and an Interview Guideline, were used. Participation in the study was voluntary and the information provided was also done voluntarily. Some information was crosschecked with other reports as well as with information available online. For the Synchrotron Case Study, additional interviews with specific content were conducted with a representative selection of Research Infrastructures. For all these interviews, Interview Guidelines and specific Questionnaires were used.

An attempt was also made to complement the results of the face to face interviews with two web questionnaires in the areas of Human Resources and Technology Transfer. These questionnaires were developed and distributed among representatives responsible for Human Resources and Technology Transfer at RIs in Europe. Unfortunately, the response rate for this method was much too low to be useful for quantitative analysis in this study. The minimal results obtained added minimal new information to the study, though they did reaffirm the results of the first two methods. Furthermore, some additional qualitative aspects could be considered.

3.3.1 Scope

The European Commission, DG Research, defines RIs as "facilities, resources or services that are needed by the research community to conduct research in any scientific or technological fields. This definition covers:

- Major equipment or groups of instruments used for research purposes;

- Permanently attached instruments, managed by the facility operator for the benefit of all users;
- Knowledge-based resources such as collections, archives, structured information or systems related to data management, used in scientific research;
- Enabling information and Communication Technology-based infrastructures such as Grid, computing, software and communications;
- Any other larger entity of unique nature that is used for scientific research.

RIs may cover the whole range of scientific and technological fields. They may be single-sited, distributed, or virtual. Examples include singular large-scale research installations, collections, special habitats, libraries, databases, biological archives (…).” (ref. 4 on p. 83).

As stated in Deliverable D1 in the 2005 EU survey conducted in the years 2004-2005 (ref. 2. on p. 83), about 742 Research Infrastructures in different scientific fields in Europe were registered. The new survey, published in July 2007 (ref. 4 on p. 83), assumes at least 598 validated research infrastructures in Europe. Nevertheless, it is reasonable to assume a total number of at least 600 Research Infrastructures in Europe.

The categorisation of the examined Research Infrastructures into scientific domains was done according to the ESFRI-Roadmap. The Interviewees were asked to categorise their infrastructures according to this codification – this was crosschecked with the categorisation of the ESFRI-Roadmap and changed with the agreement of the interviewees, if necessary.

As presented in the introduction to this report, the study is focused on Research Infrastructures, not on the institutions which host the infrastructures. But, of course, some information is only available at an institutional level; for example, services such as licensing are generally done on the institutional level. The individual chapters explain if and why the analysis has been done on an infrastructural or institutional level. However, the term RI (or RIs) always refers to Research Infrastructures.

3.3.2 Focus

Work Package 1 - the Benchmarking Activities and Good Practices selection - consists of an evaluation of the profile of European Research Infrastructures. According to the Description of Work of the ERID-Watch project, Best Practices should be identified and benchmarked in the areas of

- know-how and technology transfer (Classical TT, IP Management, Cooperation contracts)
- sub-contracted tasks to industry
- financial partnership (as, for example, public-private partnerships)
- legal environment in all areas described.

The questionnaire used for the face to face interviews should give an overview of the aforementioned fields in the RI operation. The case study on synchrotron usage reflects the specific situation in the running of synchrotrons with special regard to the use of synchrotron radiation for industrial purposes. The web questionnaires were designed to provide a more superficial glance at a larger number of respondents.

In November 2006, at a very early stage of the project during the Kick-off Meeting in Paris, the idea of common questionnaires for WP1 and WP2 was raised. The main reasons for this idea were obvious: saving money for travel costs, reducing the contacts with the RI representatives to the necessary minimum for the gathering of all information, and the ability to gain a comprehensive understanding of the infrastructure versus only partial understanding of single areas of the RIs. Following this approach, common questionnaires were used and an ongoing exchange between the three interviewers of the two WPs ensured the quality of the interviews.

During this process, it became more and more obvious that parts of the Deliverables were better suited to the other Work Package. It was agreed that WP 2 would take over the Public-Private Partnerships section including sub-contracted tasks to industry from WP1, as this area is strongly connected with the financial data of the Research Infrastructures. In return, WP1 took on the task of reporting about human resources information and patents. Finally, it turned out to be too complex a task to deliver a separate study of the legal situation of the RIs, as legal aspects are very manifold and diversely interwoven within the different fields of an RI's activities. Thus, legal aspects are not recorded separately but reflected in the sub-sections of this report. So, the final content of this study concentrates on Best Practices and a general benchmarking in the areas of

- general information on RI organisation
- know-how and technology transfer (patents, licenses, spin-off companies)
- human mobility and resources
- service for industry , especially at synchrotrons

3.3.3 Structure of Work

The Work Package leader of WP1 is Dr. Karsten Wurr, head of the DESY Technology Transfer office. The basic work was carried out by Karsten Wurr, Katharina Henjes-Kunst, Katja Kroschewski and Derek Kruse at DESY. All interviews conducted by WP1 were done face to face with two interviewing documents – the Pre-Questionnaire and the Interview Guideline. Experience has shown that these kinds of interviews are more efficient when the questionnaire is completed prior to the interview where additional details could be clarified. Furthermore, the personal contact during the interviews contributed to the sharing of the project's basic messages with the RIs, which encouraged the latter to become expert partners of and actively involved in ERID-Watch. Similar experiences were made during the synchrotron usage case study, even though four of these interviews were conducted via telephone.

The Pilot Group of WP1 was involved in the definitions and the general processes. Two meetings of the WP 1 Pilot Group (PG) took place in early to mid-2007, and a third meeting occurred in March 2008. The first PG meeting on the 7th of February 2007 was dedicated to discussing the sample, the method, and the first ideas of the questionnaire. The Pilot Group members were involved in the pre-testing of the questionnaire documents, and these were reworked with the input of the members, provided via e-mail. The complementing experiences of the different PG members turned out to be essential for the development of the documents. The second meeting took place on the 2nd of July 2007. It was concerned with the first results, the preparation of this report, and a first discussion of the scope of the study's second year.

Several additional contacts at RIs in underrepresented countries or scientific domains were provided by the Pilot Group members. A third meeting took place in Hamburg on March 11th, 2008. The main topics of this meeting were the results of ERID-Watch WP1 as well as the major tasks for year two.

3.3.4 Timeframe

The timeframe of WP 1 for the duration of the entire project can be divided into three phases:

- Preliminary phase: Scope and Definition, summed up in D0 and D1
- 1st working phase: Broad Survey and Basic Conclusions, summed up in D2
- 2nd working phase: Refining of data and Recommendations, summed up in this D3

The **preliminary phase** lasted until the end of February 2007 (see D1 for description). It was basically concerned with defining the scope of this study, setting up the sample, and building the structures for the following phase. In the preliminary phase, the interview questions were developed.

The **1st working phase** lasted through the end of September 2007 and could be divided again into three periods:

1) March- April 2007 – pre-testing period: The first two months of phase 1 were concerned with pre-testing of the questionnaires. From this phase, important input was transferred into further development of the interview documents. By the end of April 2007, two common final interview documents for both work packages had been established.

- **Pre-Questionnaire:** The Pre-Questionnaire mainly asks for figures (in areas such as TT, HR, and Finances). The pre-tests showed that it is hard for the RI representatives to provide figures offhand at the face to face interview without having any special information about the figures needed beforehand. Therefore, the Pre-Questionnaire was developed to be sent to the RI prior to the face to face interview.
- **Questionnaire or Interview Guideline:** This document contains questions from both work packages referring to processes and activities and not to numbers or figures. Moreover, these questions may need some explanations, as not all contact people at the RIs drew the same understanding from the questions. Even the distinction we made between RIs and institutions was not clear to all. To ensure the quality of the answers, direct exchange was necessary.

2) April-September 2007 - field work period: During this period, more than 47 Research Infrastructures were interviewed using the Pre-Questionnaire and the Interview Guideline. Depending on the degree of preparation on both sides as well as the size of the infrastructures, these face to face interviews could last from 2 hours (small infrastructures with only 1 contact person) to up to two days (big infrastructures with up to 8 contact persons from different departments).

3) July-September 2007 - analysis period: A WP1 Pilot Group meeting opened up this period where the main focuses of the D2 Deliverable and of the Data Analysis were discussed. This was followed by the crosschecking and complementing of the data with all involved interviewers and, finally, the analyses. The analysis period included feedback on the report by several ERID-Watch bodies after which the report was reworked.

The **2nd working phase** started after the Midterm Review in October 2007 with input from all ERID-Watch bodies and expert partners regarding the second year of this study. The general aim of this phase was, as stated in D1, to broaden and to refine the available data. Furthermore, it is important to verify characteristic key figures and important parameters and processes and to identify additional ones, for which the web questionnaires were planned.

3.3.5 Reliability of the results

This report displays an analysis of all interviewed RIs. However, one must take the following into consideration:

- the number of RIs interviewed in the aforementioned thorough manner (51) is low in comparison to the total number of existing RIs in Europe (≥ 600)
- participation of RIs could not be achieved fully proportionally across all countries and scientific domains studied
- not all questions in the documents could be answered by all Research Infrastructures with the same degree of detail – and often only at the institutional level, not the RI level
- there was often no possibility to check the accuracy of numbers and information given, as much information has not been and will never be published in such detail

Therefore, the numerical results of this study cannot be seen as being fully-fledged representative figures. Rather, they have to be taken as semi-quantitative indicators for the qualitative issues of this study.

The study was conducted on a voluntary basis. There was a disproportionate number of contacts and greater interest from the Research Infrastructures from the scientific domains of Astronomy, Astrophysics, Nuclear, & Particle Physics as well as Material Sciences, since most of the legal partners of this project originate from these two domains. Moreover, two big groups which are partners of ERID-Watch, EIROFORM and ERF, mainly organise the aforementioned scientific groups. Other expert partners were involved from Environmental Sciences as well as from Biomedical and Life Sciences – the participation in these domains was also high. The less represented domains, as seen in Figure 1, are the domains of Energy, Social Sciences and Humanities, as well as Computer Sciences and Data Treatment. These experiences correspond with both the results of the EU survey 2005 as well as the scientific domains of the legal partners of ERID-Watch. In the end, this means that the significance of the results is less meaningful for the underrepresented domains. In the second year of the study, infrastructures in these domains were actively sought out in order to make the results more statistically representative, but the response rates in these domains remain insufficient.

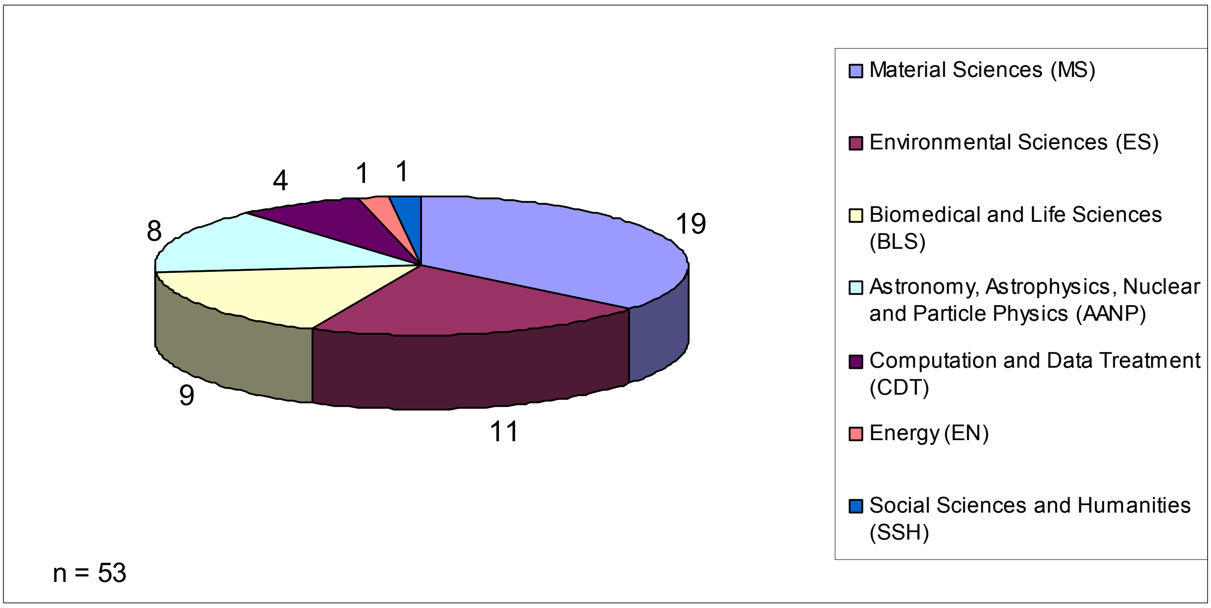

Figure *1* Scientific Domains of interviewed Research Infrastructures

Most of the legal and expert partners are from old European member states (EU-15), which partially explains the low participation rate of new European member countries (EU-12) in the study. Moreover, as the 2007 EU survey shows (ref. 4. on p. 83), about 80% of the RIs that the survey designated as "EU" are located in the EU-15 countries, and of these, 50% are located in France, Germany, the United Kingdom, and Italy. This corresponds roughly with the large representation of these countries in ERID-Watch.

Nonetheless, during the second year of the study, active efforts were made to obtain additional responses from RIs in EU-12 countries. These efforts were somewhat successful, although the number of EU-15 RIs still vastly outnumbers those from EU-12 countries.

3.3.6 Data collected

As the new 2007 EU Survey was not yet published at the start of this study, the EU survey of 2005 was the largest available collection/evaluation of RIs in Europe. Consequently, it was used as the starting point for this study. The ambitious scope and the limited timeframe of the study only allowed for the evaluation of parts of the known European RI landscape. Two criteria were selected for the definition of the sample of RIs in this study:
1) The **clear European dimension** in the work of the RI; and
2) The **number of external users** compared to staff of the RI (more than an average of 20% external users).

Additional criteria for the study's sample were:
1) The **scientific domain** (according to the ESFRI roadmap). The domains should be represented roughly proportionally to their percent value in the ESFRI roadmap.
2) The **nationality –** Interviewed RIs should originate from all 35 states within the European Research Area (ERA) and should be represented in this study in a sense of proportion, if

possible. In contrast to the EU survey, RIs operated by intergovernmental organisations were not classified in this study under their host country, but rather as “EU”.
3) The **type of RI** (single-sited, distributed or virtual). This study tried to consider the different types of RIs roughly proportionally to the respective percent values in the 2005 EU survey.

The criteria for the sample were discussed in several ERID-Watch bodies, and feedback was included. Two groups, the **EIROFORUM** members, who represent the large RIs with multinational shareholders, as well as the **ERF** members, who represent the large national RIs with international users, were defined as being essential for the sample. Furthermore, a target was set of interviewing as many of the RIs of ERID-Watch’s Expert Partners as possible.

A sample was planned in collaboration with WP2, and the list provided as an appendix to the D1 Deliverable.

Already during the preliminary phase, it became evident that not all RIs listed in this manner were willing or able to participate in the study during the interview phase. Hence, the sample was updated with RI contacts from several origins. First, the members of all ERID-Watch bodies provided RIs and contact persons. Additional contacts arose from interviews that WP2 conducted with governmental bodies of the member states. Direct contacts, e.g. at the ECRI conference, turned out to be a third way to encourage RIs to participate in the study. Especially towards the end of the interview phase, the aim of considering a wide range of countries and scientific domains in this study became the primary guideline in the choice of which RIs to interview.

Interviews were conducted with Research Infrastructures active in all scientific domains, of all different RI types, and originating from 16 European countries, as shown in Figure 2. Included are several European infrastructures with participation of several member states (these are classified as “EU”). All in all, by the 24th of August 2008, 38 institutions had been interviewed and information on 53 research infrastructures hosted by these institutions had been gathered. Participation was on a voluntary basis and even if an RI participated, it was not obliged to answer all questions. The result of this policy is that several questions have not been answered by all RIs, and not all parts of the analyses could be performed with a complete set of information. See section 7, p. 86 for details about the RI sample of ERID-Watch WP1.

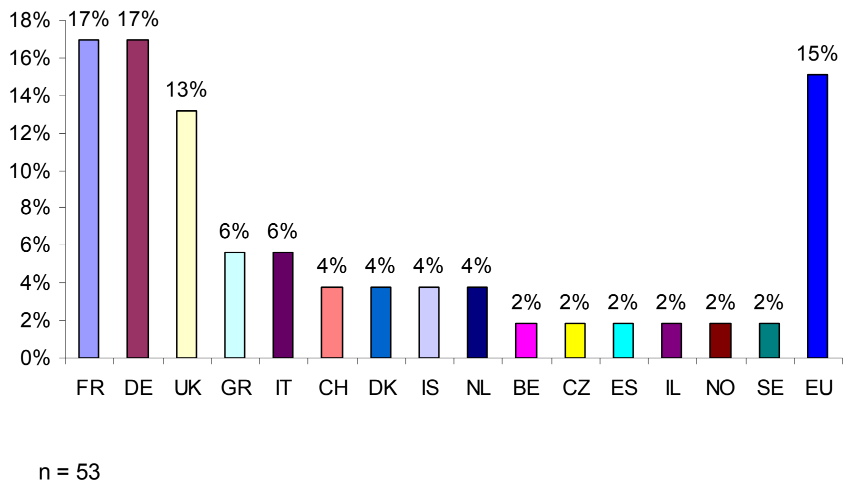

Figure *2* Countries of Interviewed Research Infrastructures

Figure 3 shows that the overwhelming majority of interviewed RIs, namely 90%, are single-sited. According to the European Science Foundation's 2007 report (ref. 4. on p. 83), approximately two-thirds of all European RIs are single-sited. While the figures in this study may be somewhat over-representative of single-sited infrastructures, they certainly are in keeping with the general trend for European RIs. The remaining RIs are either distributed among several sites or virtual, i.e. based on digital databases.

A glance at Figure 4 shows that the under-representation of RIs from the scientific domains of Computer and Data Treatment and Social Sciences and Humanities may have played a direct role in the under-representation of virtual infrastructures, whereas the over-representation of RIs in the Material Sciences domain may have led to the overly large share of single-sited RIs in the study.

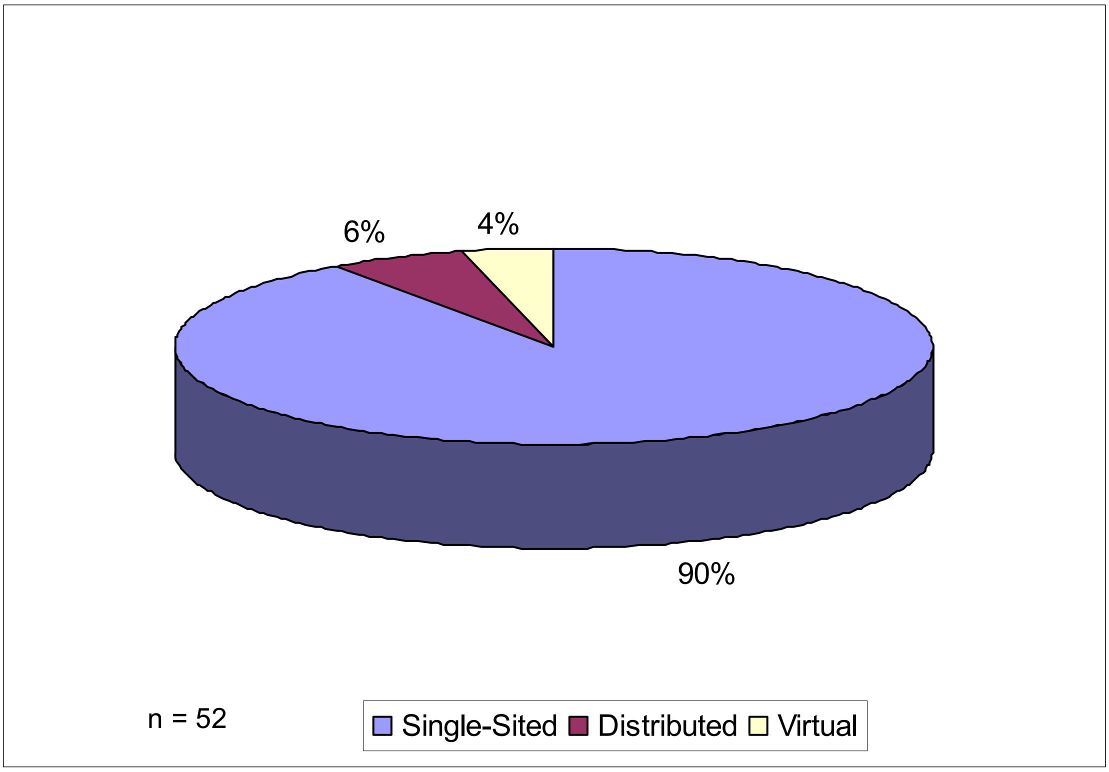

Figure 3 Type of Research Infrastructure

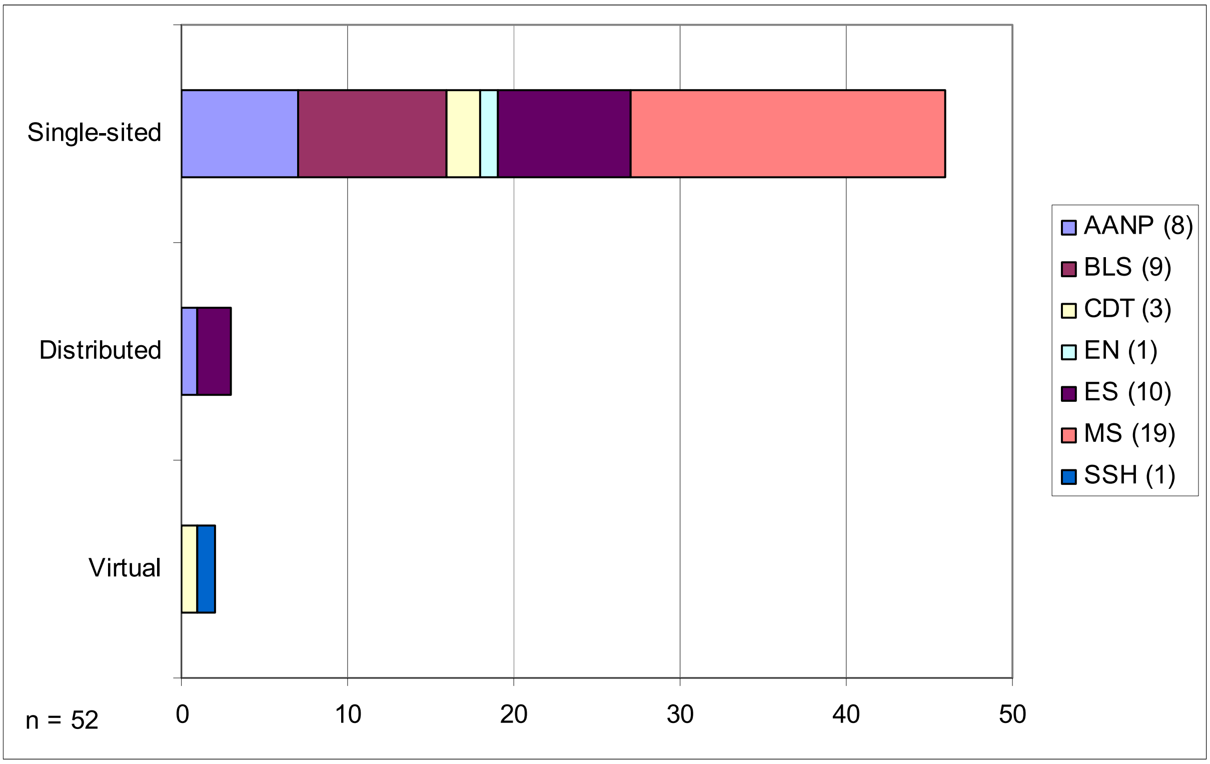

Figure 4 Type of Research Infrastructure by Scientific Domain

3.4 Acknowledgements

This report concludes the ERID-Watch WP1: "Benchmarking and Best Practices". The work of this WP was conducted with the help of all ERID-watch partners and RI operators from all over Europe and the US, as well as other stakeholders in and around RIs. We would especially like to thank all interviewees within the Research Infrastructures and the organisers of these interviews.

4 Data

4.1 RI General Information

During the interviews, four different RI organisational structures were found. More than half of the examined RIs belong to a Research Institution which hosts several Research Infrastructures.

This category is predominant in the scientific domains of Astronomy, Astrophysics, Nuclear & Particle Physics; Biomedical and Life Sciences; Environmental Sciences; and Material Sciences. The category of "Main RI hosting several pieces of equipment" can only be found in the domains of Material Sciences and Biomedical and Life Sciences. The majority (76%) of the institutions which host RIs are not integrated in any umbrella organisation.

The age of the interviewed RIs varies significantly; some date from as early as 1750.

A high number of the interviewed RIs built in the 1980s (56%) were concentrated in the Environmental Sciences domain (e.g. research vessels), while in the 1990s, 44% of the newly built RIs belonged to the Biomedical and Life Sciences. Of the 10 interviewed Research Infrastructures that were built in the last 8 years; 50% were Material Sciences RIs and 20% Biomedical and Life Sciences RIs.

Nearly half of the institutes have the legal status of research institute, agency or university-attached department under public law.

Only about 60% (32 RIs) of the interviewed infrastructures could provide data on the distribution of industrial and scientific usage. Of these, six reported no industrial users at all. Among the RIs that could provide data, 14% of the total reported usage was allocated to industrial users. This might seem a high average, but it is distributed very unevenly, as only four infrastructures have a very high share of industrial usage, namely 90%, 60% and twice 30% (one each from Material Sciences, AANP, Environmental Sciences and Biomedical Sciences).

The number and the home countries of visiting scientists at RIs are seldom collected within the RI and seem to have minimal importance with regard to the connection between RIs and industry.

4.1.1 Organisation of Research Infrastructures

During the ERID-Watch 1st phase, different organisational types of Research Infrastructures were analysed. As explained in the methodology, Research Infrastructures are to be distinguished from Research Institutions. During the field work several types of relations between these two were found.

- **1) Main Research Institution hosting one Research Infrastructure: 5 out of 53 institutions** interviewed are of this kind. An example therefore is “L'Institut national de physique nucléaire et de physique des particules” (IN2P3) in France, which hosts a computation centre RI. In this case, the research institution does not only exist because of the RI, the RI is just one part of its research facilities.
- **2) Main Research Institution hosting several Research Infrastructures: More than half** of the examined institutions are of this type. However, the numbers of infrastructures hosted by the institution vary significantly – from two to more than ten infrastructures. Among these 18 Main Research Institutions which host several RIs were seven institutions which host 2 infrastructures, two institutions which host 2-5 infrastructures, three institutions which host more than 5 infrastructures and six which host or participate in more than 10 infrastructures. Examples of the latter are: DESY, CERN, ESA, and AWI.
- **3) Main Research Infrastructure hosting one major piece of equipment: This type of organisation was found in 8 institutions**, for example at Soleil. The Soleil Synchrotron for example is one big piece of equipment which constitutes the RI. French RIs made up the majority of this organisational type.
- **4) Main Research Infrastructure hosting several major pieces of equipment: These made up the smallest group of interviewed RIs – only 3 of this type were found,** among them the Copenhagen Animal Research Unit. As the number of RIs in this category is so small, no further statement is possible about the spread of countries or scientific domains.

Five of the interviewed institutions could not be categorised in this way at all, as not enough information were available to ensure an appropriate categorisation. The characterisations described above are illustrated in Figure 5.

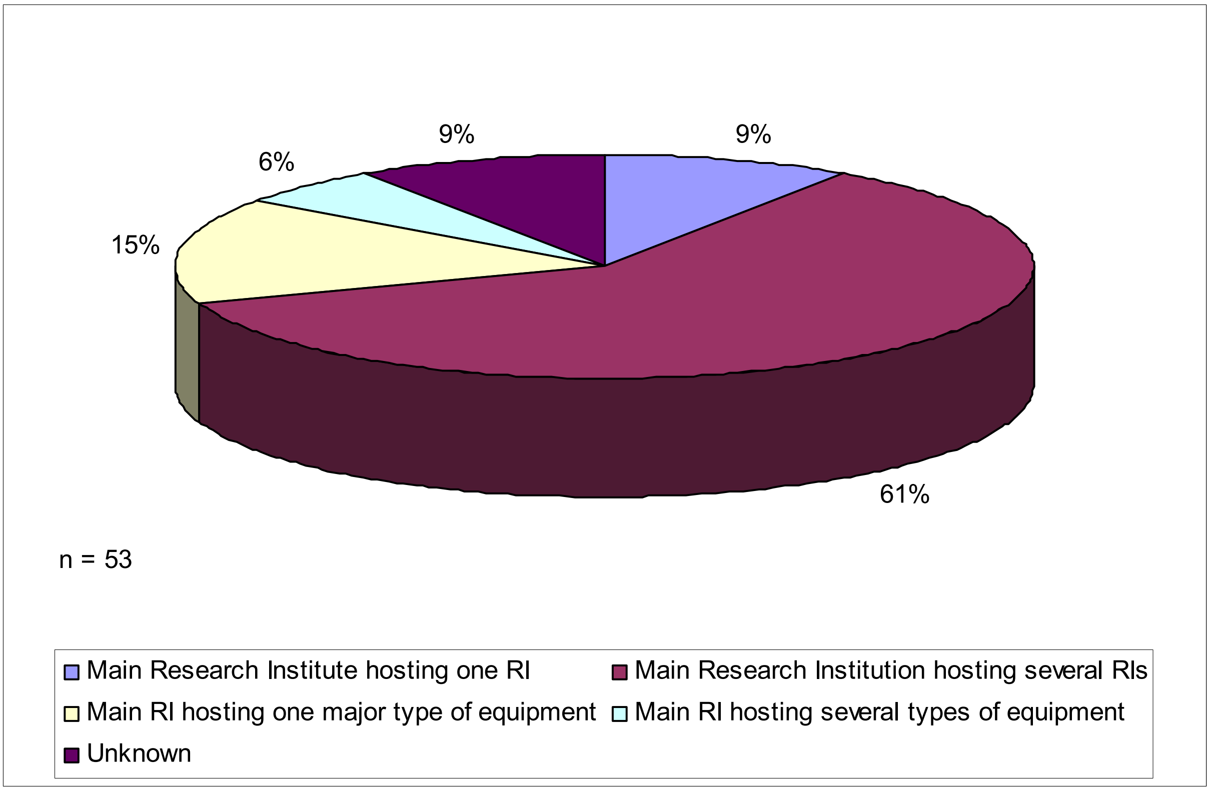

Figure 5 Organisational Structures of Interviewed Research Infrastructures

Figure 6 gives an overview of the organizational structure of the interviewed research infrastructures categorized by scientific domain. The category "Main RI hosting several pieces of equipment" can only be found in the domains of Material Sciences and Biomedical and Life Sciences, while the category "Main institution hosting several RIs" is predominant in the scientific domains of Astronomy, Astrophysics, Nuclear & Particle Physics; Biomedical and Life Sciences; Environmental Sciences; and Material Sciences.

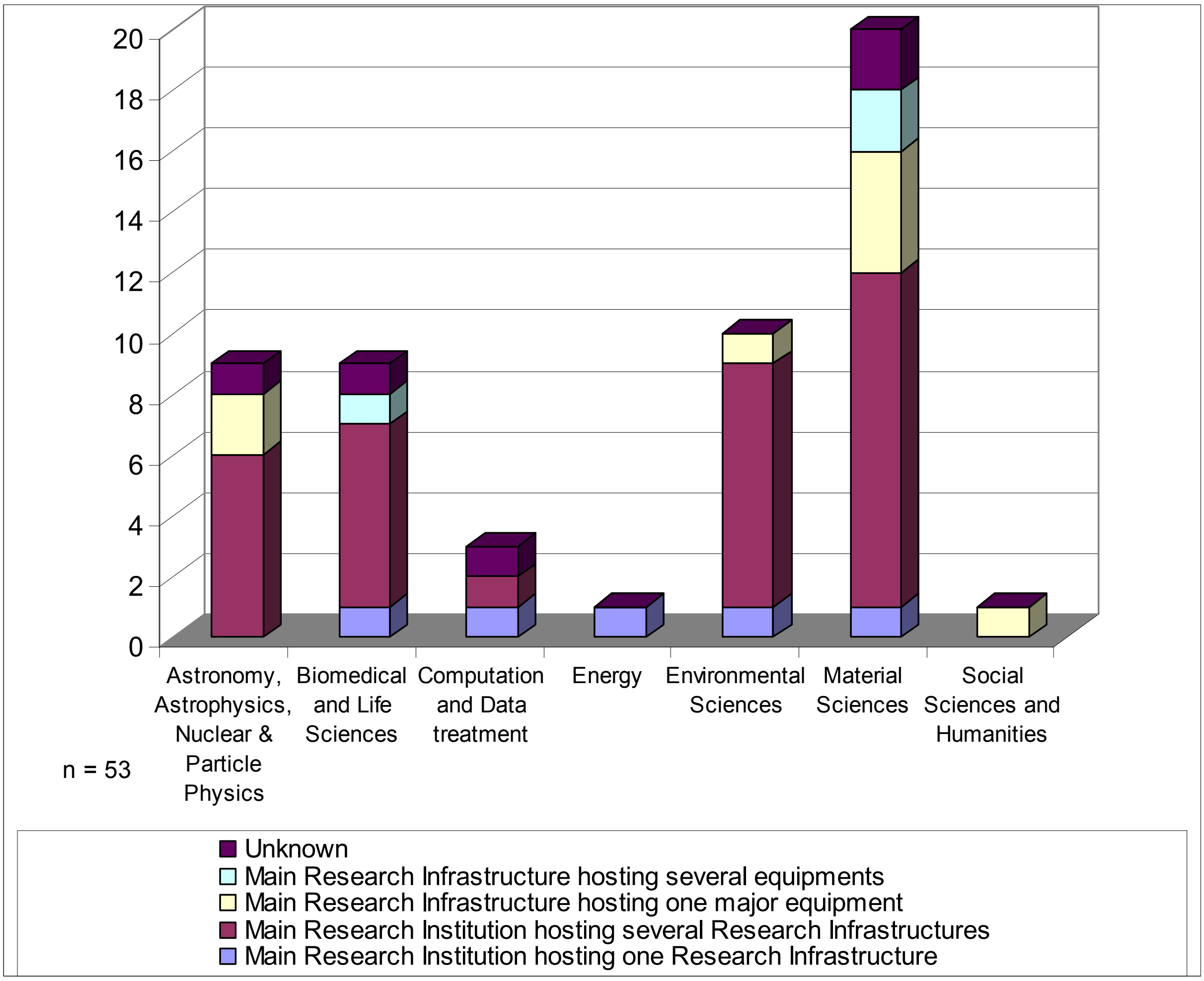

Figure 6 Organizational Structure of Interviewed Research Infrastructures by Scientific Domain

4.1.2 Umbrella organisation

Umbrella organisations mostly exist at the institutional level. This means that the institution, not the infrastructure, is part of an umbrella organisation. Of the 38 interviewed institutions, nine institutions (24%) are integrated within such an umbrella organisation, for example the Helmholtz Association, CNRS, or FOM. Of these nine institutions, seven of them are situated in France or Germany.

The large majority of the RIs (76%) are not integrated within any umbrella organisation. Seven of these infrastructures belong to university departments or institutions, but in these cases, the universities are not seen as umbrella organisations. Whether an institution is integrated within an umbrella organisation seems to be independent of the type or the scientific domain of the institution.

4.1.3 Age of the Infrastructures

Figure 7 gives an overview of the age of the interviewed RIs.

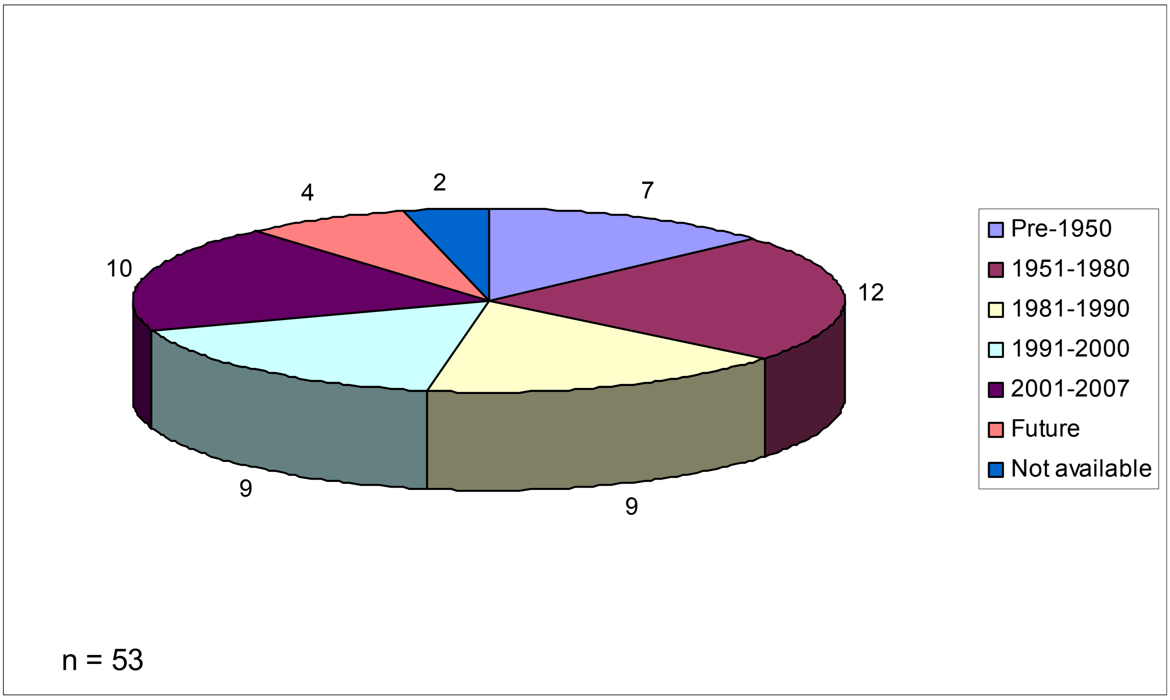

Figure 7 Founding Years of Interviewed Research Infrastructures

The age of the interviewed RIs varies greatly. Some of the interviewed infrastructures were founded as early as 1750; among the oldest are the collections in the interviewed museums or botanical gardens. This explains the high number of RIs founded before 1950 in the domains of Environmental Sciences or in the Biomedical and Life Sciences. This can be seen below in Figure 8, where an illustration of the distribution of the ages of RIs across the scientific domains is provided.

A high number of the interviewed RIs built in the 1980s (56%) were concentrated in the Environmental Sciences domain (e.g. research vessels), while in the 1990s, 44% of the newly built RIs belonged to the Biomedical and Life Sciences.

Of the ten interviewed RIs that were built in the last 8 years; 50% were in the Material Sciences domain and 20% in the Biomedical and Life Sciences domain. Two of the interviewed RIs could not be used for this analysis.

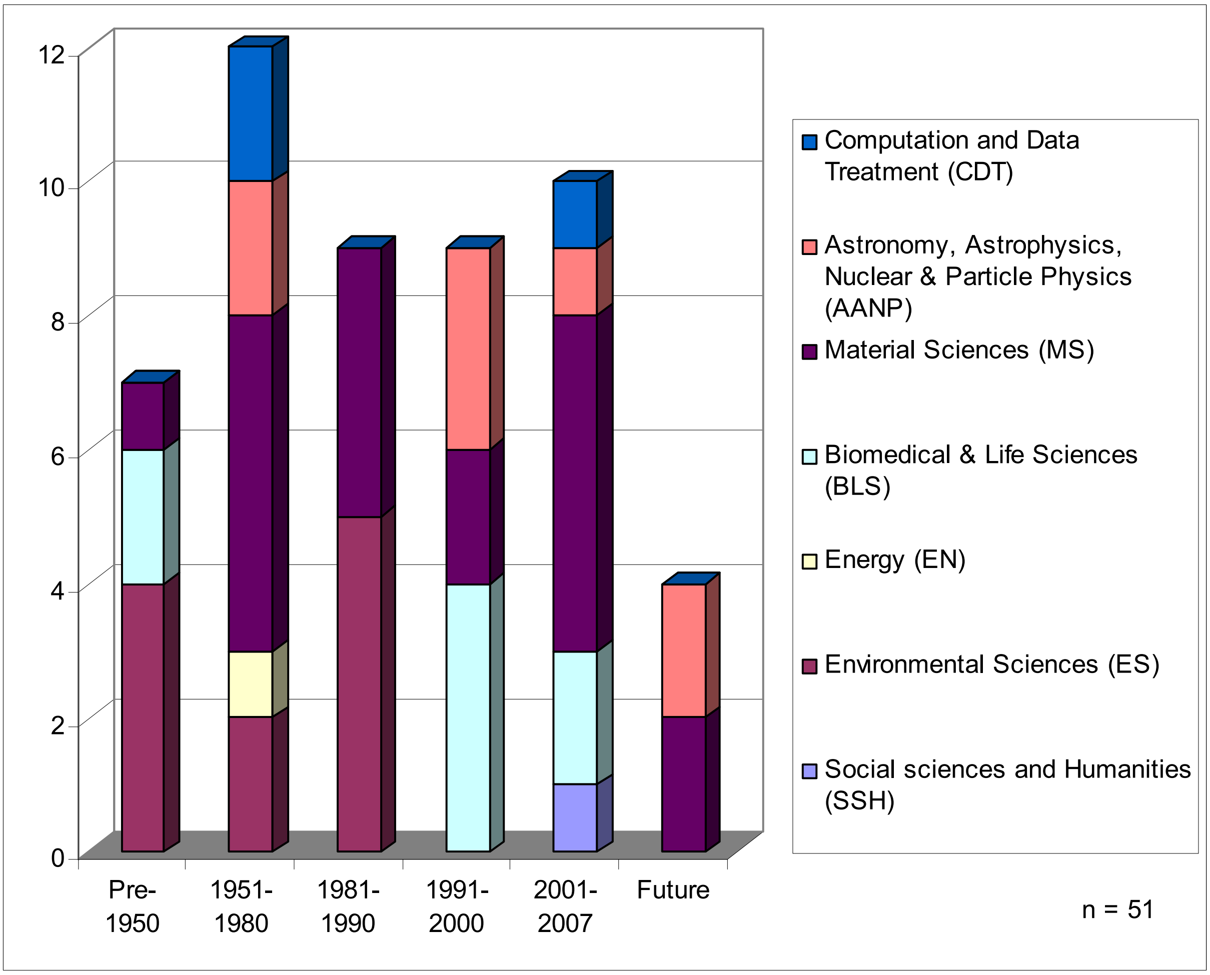

Figure 8 Founding Years of Interviewed Research Infrastructures by Scientific Domain

4.1.4 Legal Status of the Interviewed Institutions

The legal status of the different RIs interviewed was the same as the legal status of their institutions, because in general, the legal status belongs to the institution, not to the infrastructure. An overview of the legal structures of the interviewed RIs is given in Figure 9.

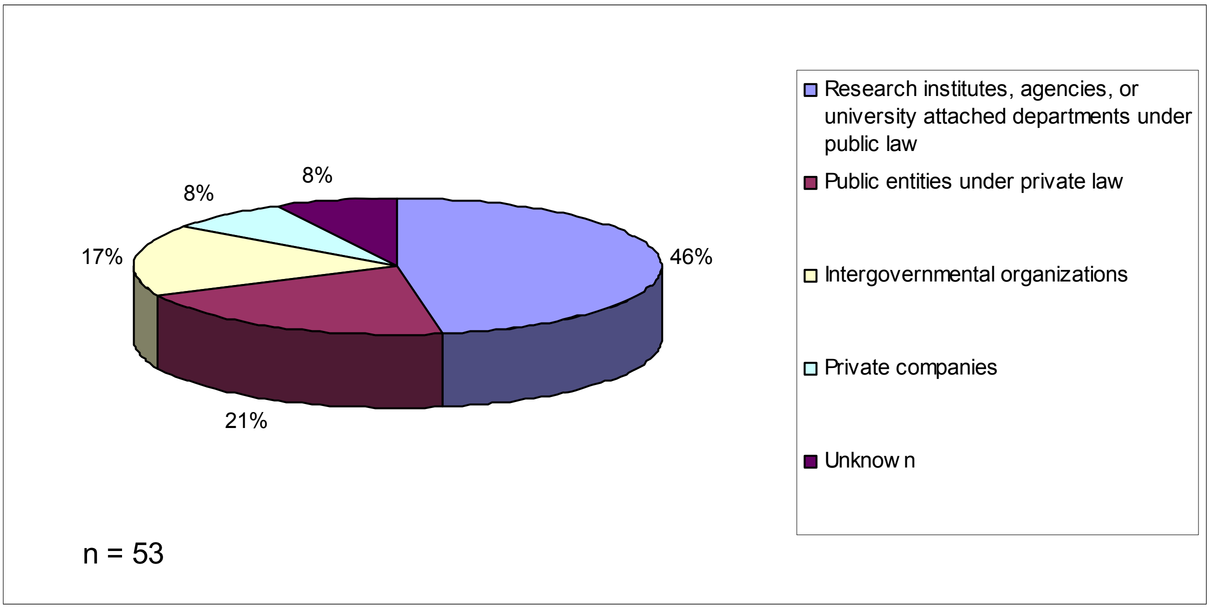

Figure 9 Legal Structure of Interviewed Research Infrastructures

The differentiation between the four different categories was made at the institutional level:

- **Private Companies:** Four of the examined institutions (8%) are private companies. No correlation to country or scientific domain is identifiable. Both private companies are single-sited.
- **Public entities under private law:** These institutions are found mainly in France. 11 of the institutions (21%) have private law status.
- **Research institutes, agencies or university attached departments under public law:** Nearly half (46%) of the institutions could be grouped in this category. This type of legal structure is found evenly distributed across all countries and scientific domains.
- **Intergovernmental organisations:** Nine of the interviewed institutions (17%) have the legal status of an intergovernmental organisation – these are the big European institutions, for example ESA and CERN.

For four institutes, no data for this particular analysis were available.

Figure 10 shows the categorization of the legal structure of RIs across the scientific domains.

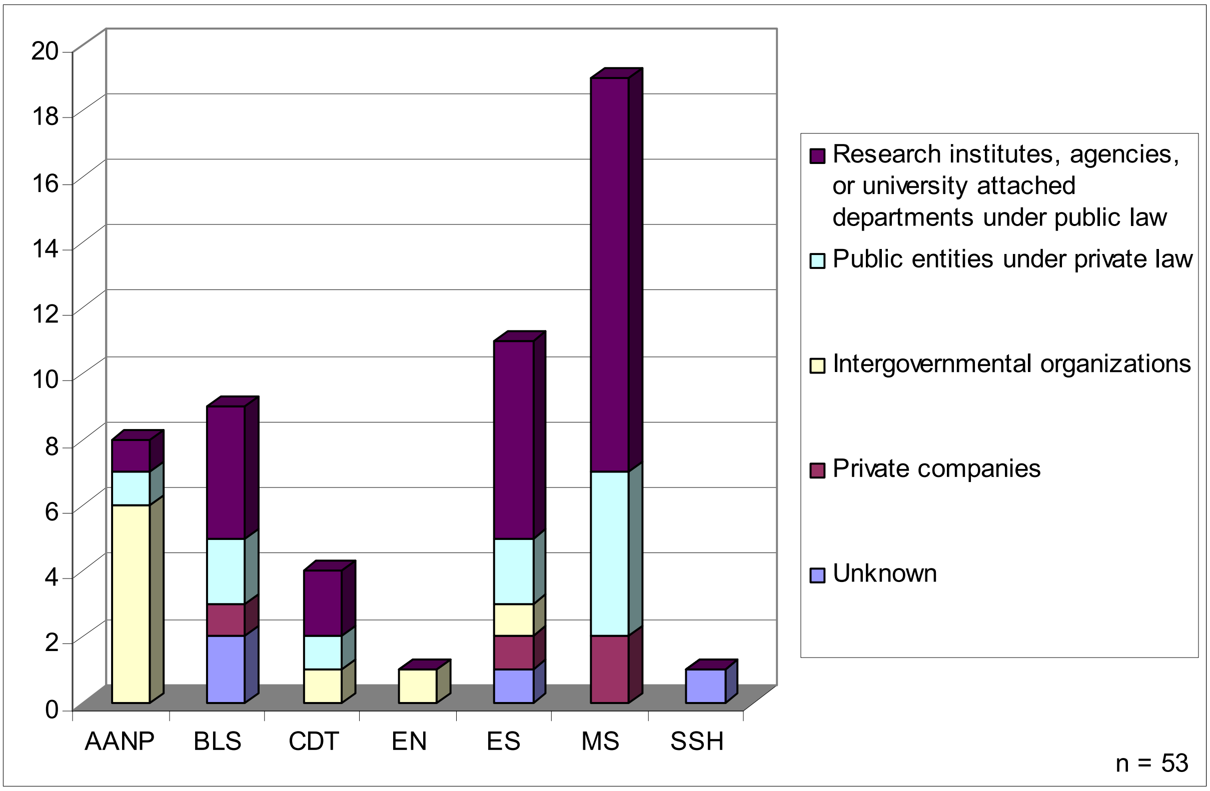

Figure 10 Legal Structure of Interviewed Research Infrastructures by Scientific Domain

4.1.5 Users of the interviewed institutions

Being asked for the target group of their users, more than 50% of the interviewed RIs answered that they have internal, external and industrial users, even if most of them added that the percentage of industrial usage is very small. Indeed, only 32 infrastructures (60% of 53 interviewed) could offer information about the distribution of usage by scientific or industrial users. Of these 6 have no industrial users at all.

The mean average industrial usage at these 32 institutes lies around 14%. This might seem high but derives from the fact that four infrastructures have a relatively high usage by industry – 90%, 60% and two RIs with a 30% industrial usage rate. These RIs come from four separate scientific domains: Material Sciences, AANP, Environmental Sciences and Biomedical and Life Sciences. If these four RIs are not taken into account, the average percentage of industrial usage falls to just 6.25% for each RI with industrial users.

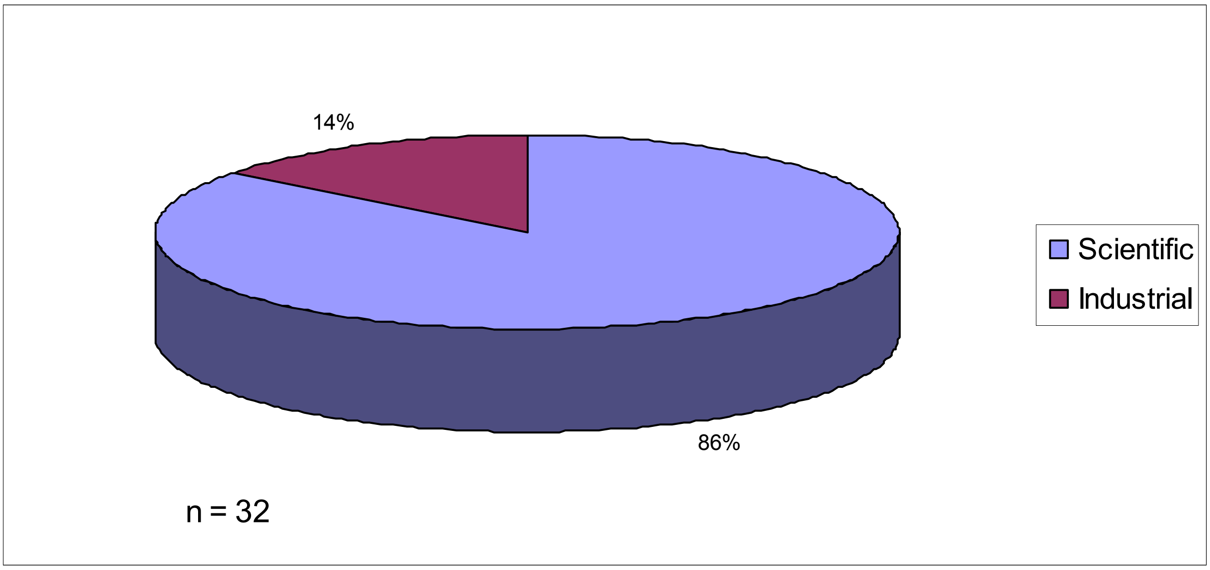

Figure 11 Users of the interviewed Research Infrastructures

The visiting scientists in the RIs are hard to compare – only 26 infrastructures gave information regarding the number of visiting scientists they host, and even some of these numbers were only roughly estimated by the interviewees. Other RIs did not count them at all or the information was otherwise unavailable. The spectrum of answers spans from just five per year to 6000 visiting scientists annually.

Similarly, information about the countries from which these users come was often unavailable. About two-thirds of the RIs that could answer this question also had users from non-European countries; in particular, the United States, Canada, Japan, Russia, as well as African countries were mentioned. The origin of the users does not appear to depend on the size or average number of users of the infrastructures, nor on the scientific domain. Some of the interviewed RIs mentioned that they are now beginning to collect more data about visiting scientists.

4.2 Know-How and Technology Transfer

Know-How and Technology Transfer (TT) were found to be organised at an institutional level at all interviewed RIs. None of the interviewed institutions handled the related issues at the level of individual RIs.

39 of 51 Research Infrastructures interviewed about TT issues reported that they had the option of using a TT-office/department, a separate TT company, or that there was a TT-responsible person that they could turn to. A further 12 infrastructures do not have this possibility.

The main funding source of TT offices is the general budget of the institution, as 23 of the 51 infrastructures (45%) state that they generate no income from their commercial activities with industrial partners. About 21 infrastructures (41%) are able to draw at least some income from commercial activities, but only seven infrastructures (14%) manage to obtain 50% or more of the money spent in this field from royalties or payments for contract research.

33 of the 51 interviewed infrastructures (65%) stated that, in principle, they offer services to industry, from mostly basic services like accommodation to full R&D service, as well as additional services such as special trainings. Engaging in patenting or licensing does not seem to be imperatively linked with the industrial usage of the infrastructures.

The annual number of the institutions' patent applications (based on responses from two-thirds of the interviewed RIs) is high in the domain of AANP and still above average in BLS and ES, while MS is somewhat below average. A large spread between many RIs having none and some with high numbers of patent applications is typical for all scientific domains. The number of total patents held by the RIs turns out to vary significantly from the number of annual patent applications, as a drastic change is seen in the domain of AANP, which is now far below the average. RIs in Germany have the highest relative possession of intellectual property rights with an average of 7.56 patents held per 100 FTE, followed by the UK with 3.49 patents.

26 infrastructures gave information about licenses. On average, just over 20 licenses were given in the last three years in these infrastructures annually- that means only ca. 0.8 licences for each infrastructure per year. The individual figures ranged from 0 to 12 licenses per year. The domains of BLS, AANP and ES are above average in giving licenses. All in all, annually just above one new license contract per 1,000 FTE indicates that giving licenses is currently not the core route for technology transfer from RIs. On average 16,434 € license income is generated per 100 FTE, which calculates to 164 € per full time employee. The RIs in the domains of BLS and MS are more successful than others in generating higher royalties with their licenses.

Spin-offs could be found in all domains with the exception of CDT, Energy and SSH. 16 out of 51 infrastructures gave no information about this topic, another 12 infrastructures have yet to produce any spin-offs and 23 RIs have had some. The number of spin-offs per institution with infrastructures normally is less than ten. The most spin-off companies per 100 FTE are found in the domain of AANP with 2.74 per 100 FTE, followed by Biomedical and Life Sciences with 1.75 per 100 FTE. All other domains are below the average of 0.95 per 100 FTE.

A problem often mentioned in this chapter is the difficulty of comparing all research infrastructures based on simple key figures. There are several fundamental reasons which lead to a totally different situation in different RIs, including the character of research carried out, the scientific domain and the potentially addressed industry branches as well as the type, the legal environment and the TT policy of an RI. Furthermore, a central issue as regards TT policy is the unresolved duality between IP protection and the traditional open science approach of public research.

Only very few institutions invest enough time, money and personnel to be able to really go proactively into the markets for a transfer of know-how and patent applications to industrial licensees. Another overall problem is determined by the extreme discrepancies in the TT approach not only among different scientific fields but also within the same field. A set of commonly used standards could simplify the TT process.

Last but not least, a more successful TT, whose potential is indicated by patent applications and whose success is proven by license income and contracts and its licenses or co-operations with industry, still requires the commitment of the researchers.

4.2.1 General problems & remarks

A problem often mentioned in this chapter is the difficulty to compare all research infrastructures based on simple key figures. There are several fundamental reasons which lead to a totally different situation in different RIs:

- The character of research carried out by an RI could be of either a basic or applied variety. The former impedes, while the latter facilitates the success of a commercial TT-approach.
- The scientific domain of an RI defines the potentially addressed industry branches which each have their own preferences in the patent and licensing business and special attitudes towards joint or even external inventions. These effects are increased by national differences in the European industry.
- The type of RI pretty much defines the results of its TT: Virtual RIs are in a very different situation than distributed or single-sited RIs. Those with a large share of external users, who keep their own intellectual property and do their own TT cannot be as successful in TT as RIs with a large share of internal users.
- The TT policy of an RI forms an important switch for all TT operations. Sometimes this policy is a sole institutional decision, while in other cases it is given by the member states. In either case, the national framework for TT, e.g. tax and funding rules, special TT funds or PPP initiatives, heavily affects the final TT results.

A central issue as regards TT policy is the duality between IP protection and the traditional open science approach of public research. Institutions, funding agencies and governments have to be properly aware of the different advantages and drawbacks of these two basic models. Whilst, e.g., industrial partners of an institution with an open science strategy may be glad that they don’t have to pay for transferring these ideas, they will on the other hand not have any protection for these ideas. Thus, me-too-products are likely to show up on the market soon.

Having only a badly resourced TT-office or even none at all doesn’t necessarily mean that the reason for this circumstance is a strategic decision. During the interviews, it was sometimes mentioned, for example, that the budget situation is the main reason that patents are given up one or two years after the application as soon as the cost increases. During these one or two years, the chances of finding a company interested in a license are very small for these normally premature technologies and the patenting cost.

Only very few institutions invest enough time, money and personnel to be able to really go proactively into the markets for a transfer of patent applications to industrial licensees. Mostly, the TT process consists of the steps of securing the IP, waiting for interested parties, and finally giving a licence away if a representative of a company or another institute asks for it. Only few institutions actively seek licensees via direct business contacts or the presentation of examples of their commercially available results on their website. Business development seems to be a foreign word to the bulk of RIs.

Another overall problem is determined by the extreme discrepancies in the TT approach, not only among different scientific fields but also within the same field. Firstly, this lack of common standards leads to a wasting of resources as partners meeting for the first time or on a new issue always have to “reinvent the wheel” to define their contractual relation. Secondly, this circumstance makes it extremely confusing for newcomers to the public TT business, like e.g. from the EU12, to define and organise their own TT approach. A set of commonly used standards could simplify the process.

Last but not least, a more successful TT, whose potential is indicated by patent applications and whose success is proven by license income and contracts and its licenses or co-operations with industry, still requires the commitment of the researchers. Some institutions already began taking measures towards this change years ago and tried to integrate the researcher in the TT process. But at this point, only a few institutions have established rules about the handling of rights and compensations for patents and licenses in favour of the researcher.

4.2.2 TT organisation

Three different kinds of TT organisation were found in the interviewed institutions:
a) TT-office,
b) TT-responsible person,
c) No TT-Office or person.

- Of 51 infrastructures interviewed regarding TT issues, 32 have the option of using a technology transfer department, office or company.
- 7 infrastructures at least have a TT-responsible person.
- 12 infrastructures did not have a TT office or even a person responsible for TT concerns.

The Technology Transfer Offices or Responsible Persons are mainly attached *as a department or directly* to the director’s office (25 RIs or about 50% of the 51 interviewed infrastructures). In 10 cases (about 20% of the 51 institutions), TT issues are taken care of by someone in the general administration or business units. Three interviewed institutions have their own companies (which are counted here as TT-offices), which they sometimes share with other institutions that handle TT (two of these infrastructures are from Biomedical and Life Sciences and one is from the Environmental Sciences domain). On rare occasions, some university-attached infrastructures are able to use the TT offices of the university. However, having the opportunity to make use of a TT office does not automatically mean that it will be utilized: three interviewees said that they were not really using them – either the university-attached TT offices or the companies.

Looking at the size of the RIs' TT offices, the following Figure 12 was assembled:

- Of 51 interviewed infrastructures, 19 had TT offices with a medium (12) to large (7) size. Offices with 3 to substantially below 10 employees are of medium size, while the large TT offices had about 10-13 employees.
- Three infrastructures using external professional TT companies have been counted as a separate group. Regarding the degree of professionalism, these companies have to be seen as at least equal to the internal large or medium TT offices.
- 17 infrastructures had either a small TT office (10) with 1 to 2 employees or a TT responsible person (7).

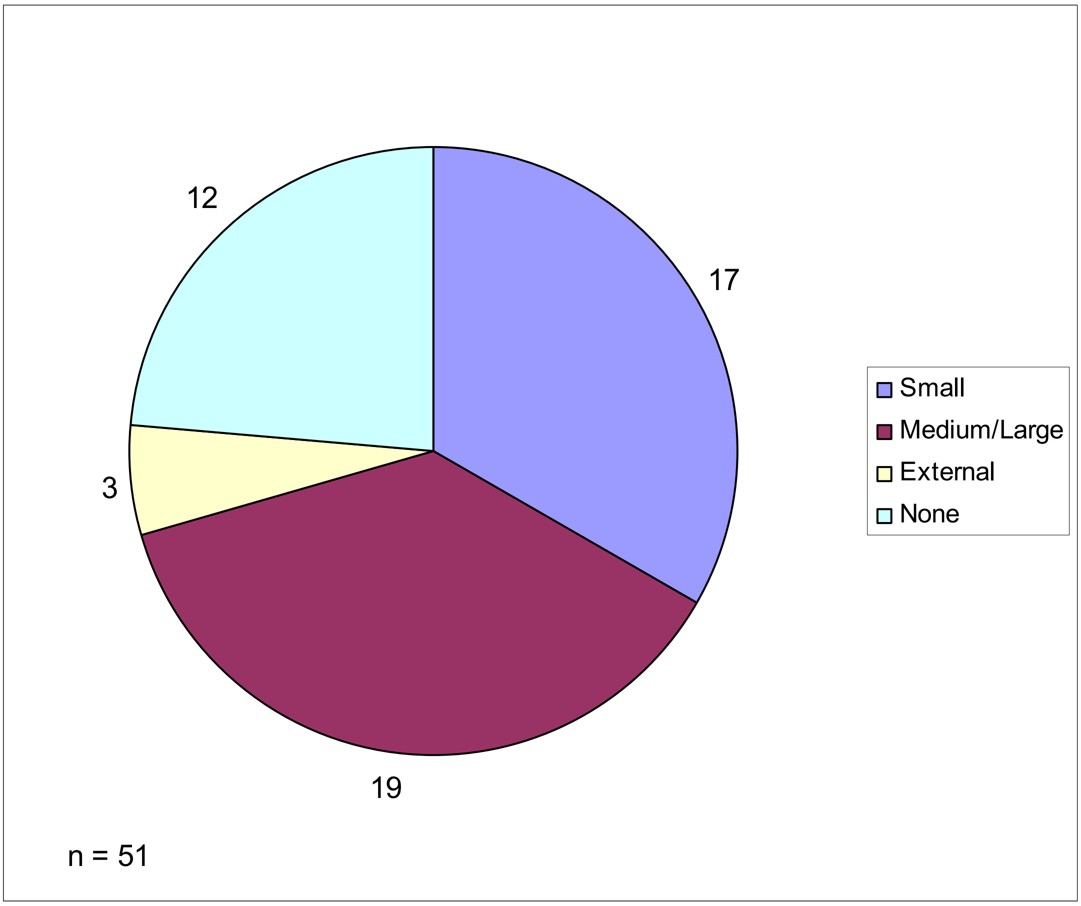

Figure 12 TT Office Size

The size of the staff (FTE) per TT-office differs quite a bit between the different scientific domains. As mentioned above, the smallest TT offices have only one staff member, while larger ones have up to thirteen people working for TT. The fact that TT is given different priority at different institutes is demonstrated by two centres in the same scientific domain and doing very similar research: the first has one TT staff member and the second has thirteen people working for TT. Even if one of these centres had twice as many staff members as the other one, there would still be a ratio of 6.5 FTE to 1 FTE.

In total, TT-staff size is largest in the domain of Astronomy, Astrophysics, Nuclear & Particle Physics. It derives from the fact that this interviewed domain contains some of the biggest institutions (CERN, ESA, etc.). But looking at the ratio of TT staff members in Figure 13 compared to the size of the infrastructures, this domain ranks only third with ca. 0.5 TT employees per 100 FTE. Higher values are found in the domains of Material Sciences (1.1 TT employees per 100 FTE) and Biomedical & Life Sciences (0.9 TT employees per 100 FTE).

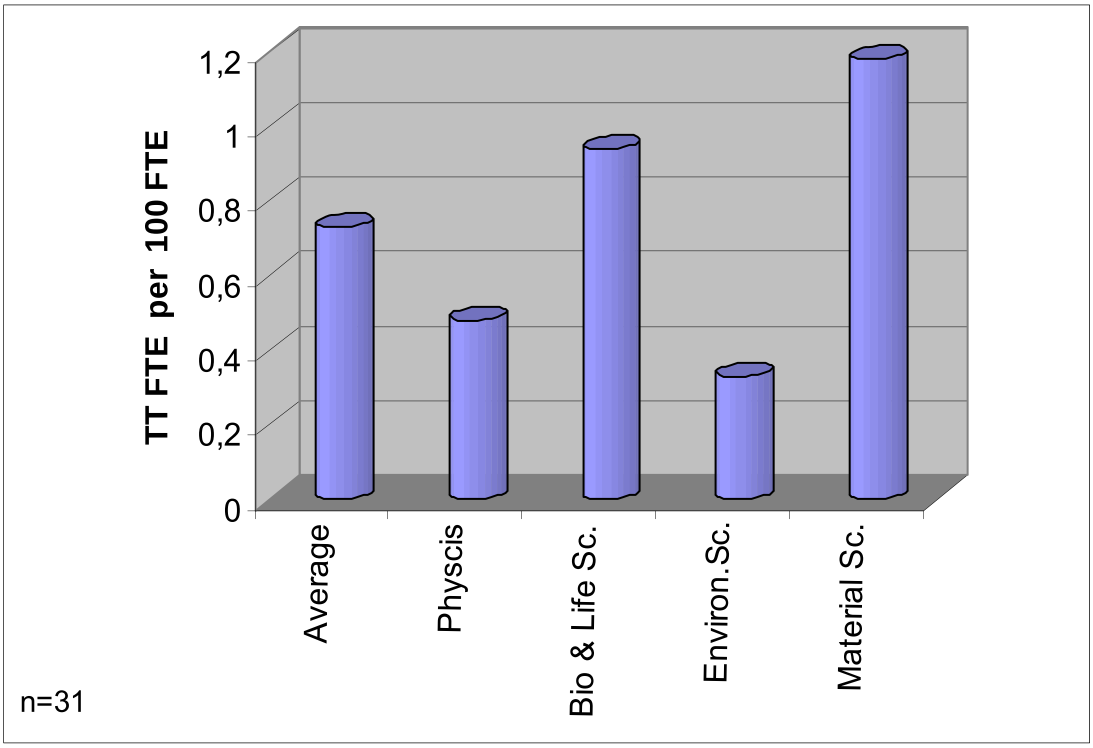

Figure 13 Average Number of TT-staff members per 100 FTE

Technology Transfer offices perform very diverse tasks within the RIs: Patenting and Licensing, (R&D) Cooperations, Spin-offs as well as other services. The diversity of tasks shows that even two TT-offices well equipped with personnel could not be compared only with key figures, as different central focuses within the work may exist.

4.2.3 TT funding and income

The main funding source of TT offices is the general budget of the institution. 23 of the 51 infrastructures (45%) state that they generate no income from their commercial activities with industrial partners. Even those infrastructures in institutions with income from commercial activities often do not organise this field as a profit centre. Consequently, these TT offices, too, are fully dependent on the central budget, where any commercial income disappears more or less unnoticed.

About 21 infrastructures (41%) are able to draw at least some income from commercial activities with industrial partners, but this is far below 50% of the cost for their TT activities. Only seven infrastructures (14%) manage to obtain 50% or more of the money spent in this field from royalties or payments for contract research. But as many types of costs, like inventors' shares, full cost of equipment use, etc., are often not taken into account, the share of infrastructures with refinancing of commercial activities above 50% is even lower than this figure.

4.2.4 Services offered

Technology Transfer at the interviewed institutions primarily includes two major issues: patenting/licensing and industrial cooperation. Additionally, spin-offs are handled in a few cases. The importance of these issues is often not at the peak of an RI's science-driven agenda and, thus, may explain why only 32 of the 51 infrastructures have a TT office or a similar department and just seven more have a TT responsible person, while 12 have neither. Moreover, the policy regarding intellectual property varies from institution to institution as well as from country to country – for example, while the strategy of protecting and licensing IP is widespread in German, French and large European institutions, in many institutions throughout the rest of Europe, open source usage policy is followed.

The issues of patenting, licensing and spin-offs will be addressed in detail in the following chapters. For industrial co-operation, some information is given below, and much more detailed information focussing on synchrotrons is provided in the synchrotron case study chapter.

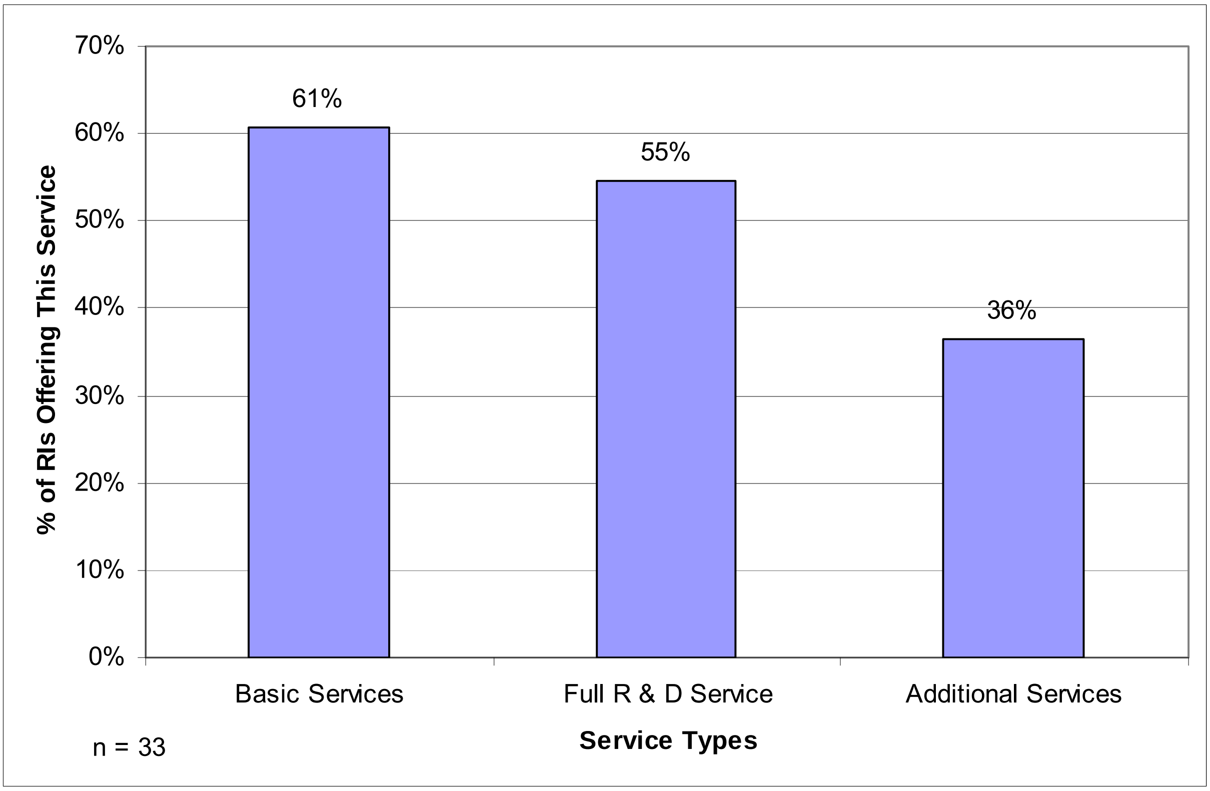

Figure 14 Services offered to industry by interviewed RIs

For some of the infrastructures, industrial usage is not an issue at all, as they are doing very basic research or do not have the opportunities to give industrial users time to use their RIs. But as shown in Figure 14, 33 of the 51 interviewed infrastructures (65%) stated that, in principle, they offer services to industry. The majority of these provided basic services (like assistance, accommodation etc.) and/or full R&D service, while about one third of the infrastructures offering service to industry included additional services, which included, e.g. special trainings, consultation or specific transportation means.

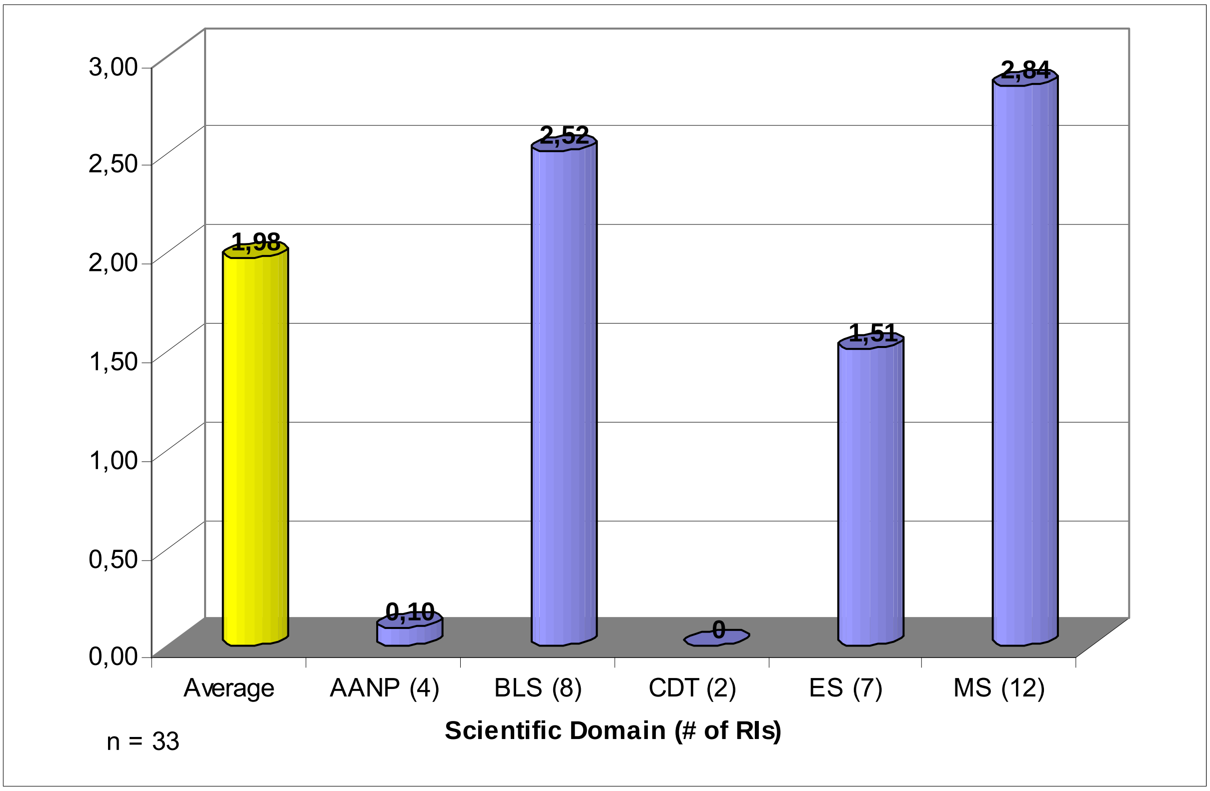

Figure 15 R&D Contracts with Industry per 100 FTEs

A glance at Figure 15 reveals that the ratio of industrial research contracts per 100 FTE is quite high in the domain of Material Sciences, directly followed by the Biomedical and Life Sciences. Taking into account that the average size of the former institutions is a bit below those of the latter, both domains are about equal as regards absolute numbers of industrial contracts per infrastructure. The domains of Environmental Sciences and even more Astronomy, Astrophysics, Nuclear & Particle Physics are below average. It may be stated that these two domains deal with less applied phenomena than MS and BLS. The other domains either did not have any industrial contracts (CDT) or did not give any information on whether they offer such services (SSH and EN).

A cross-check with the information in the following chapters shows that patenting or licensing does not seem to be imperatively linked to the industrial usage of the infrastructures.

4.2.5 Patent applications & patents

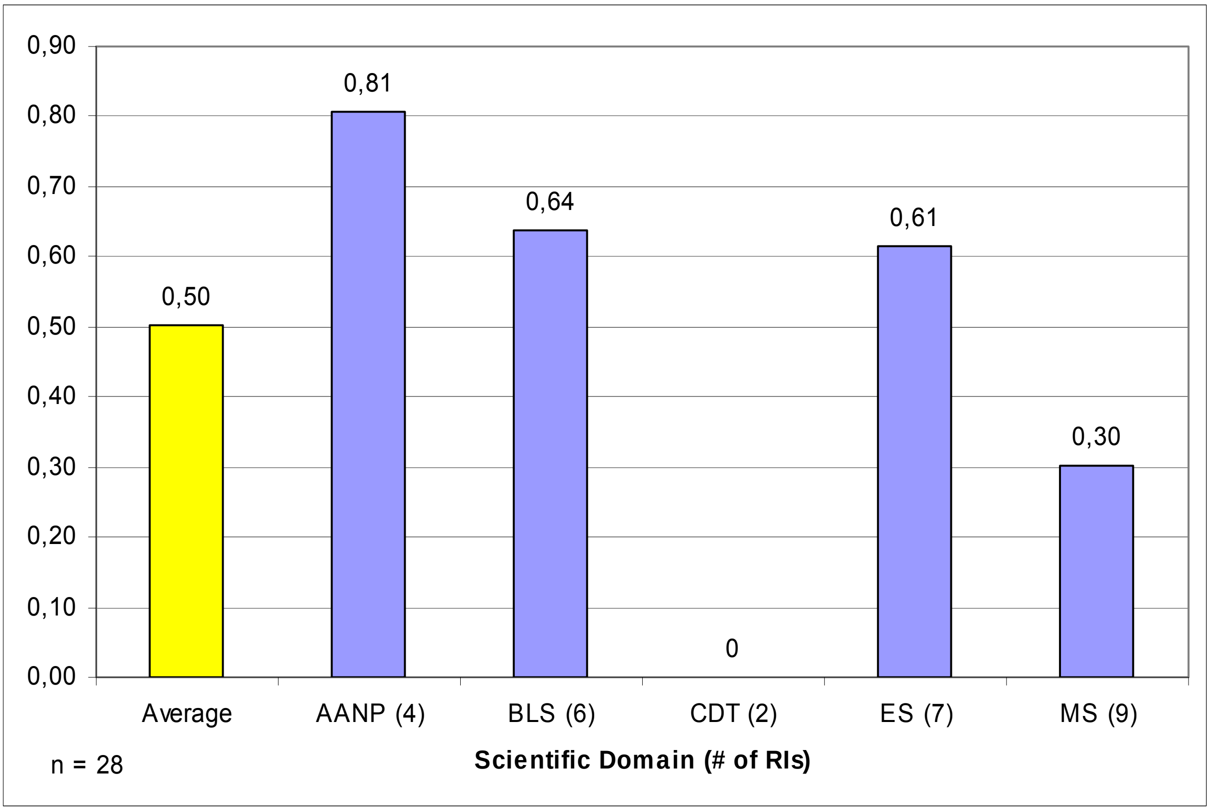

Figure 16 Annual Patent Applications per 100 FTEs

The number of patent applications per year is a basic number in the area of TT, but this number is dependent on the specific patent policy, the scientific domain, and the budget of the institution and should therefore be used carefully. The annual number of patent applications per 100 staff members of the institution is high in the domain of Astronomy, Astrophysics, Nuclear & Particle Physics as

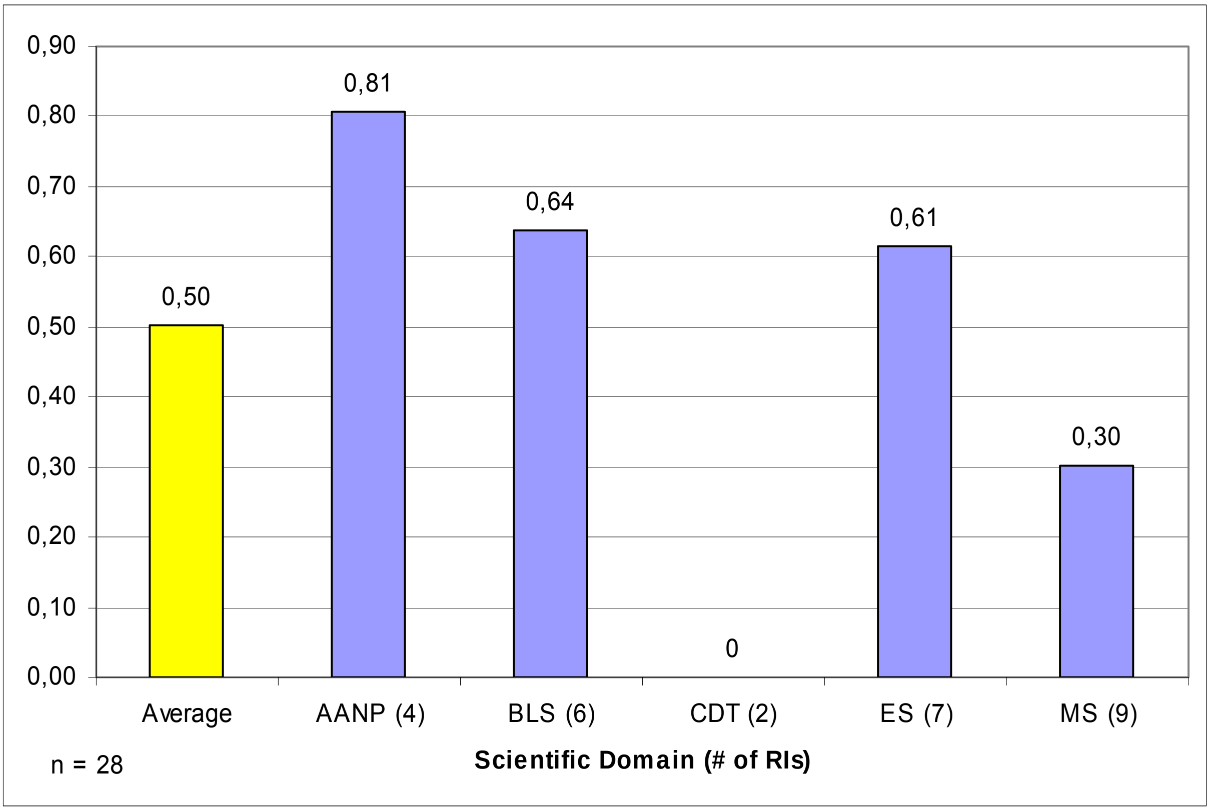

Figure 16 shows. Biomedical and Life Science as well as Environmental Sciences institutions also lie above the average, while Material Sciences falls somewhat below. The domains that are not represented in the sample (Energy, CDT and Social Sciences and Humanities) either have no patent applications currently or did not provide information in this area.

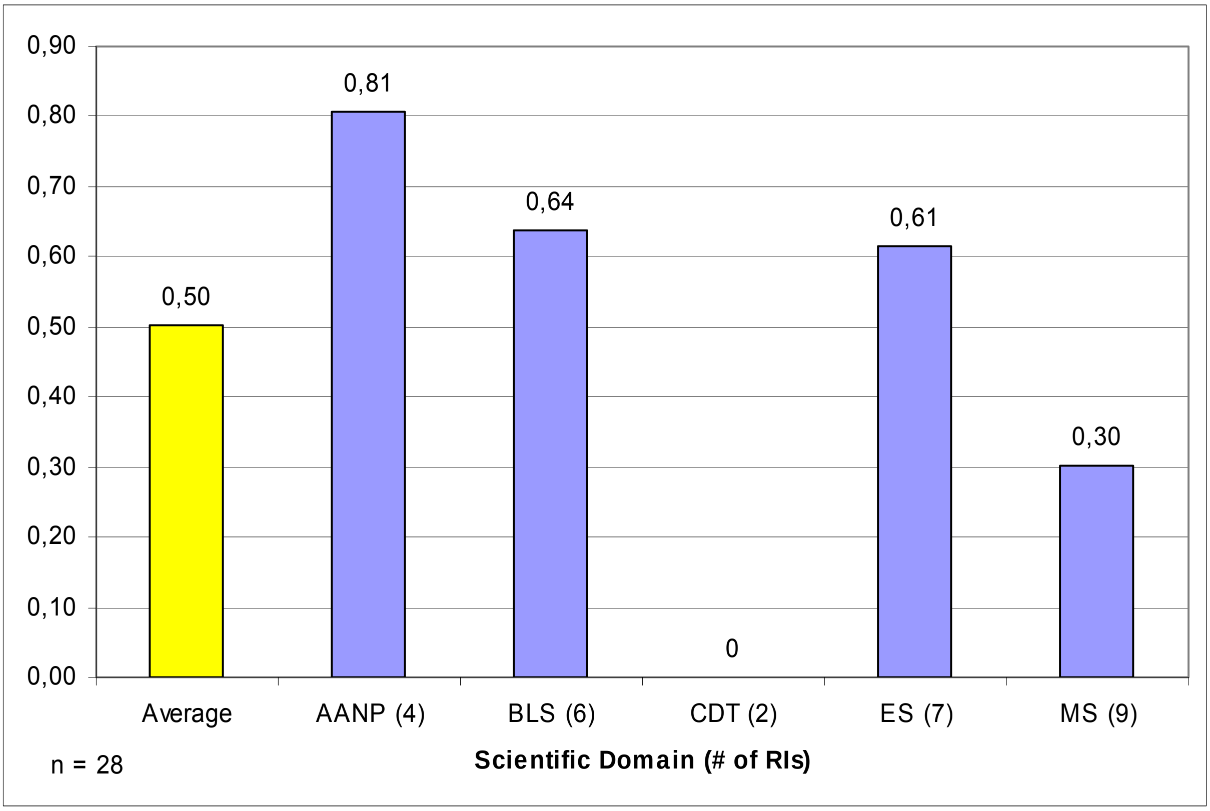

Figure 16 refers to roughly two-thirds of the interviewed institutions, as the other ones did not have information available for this area. In the Physics domain, two institutions (both intergovernmental organisations) had very large numbers of patent applications per year, while the other institutions in this domain had very few or none at all. This is typical for all scientific domains: most of the institutions have no patent applications or up to one or two per year, and a small number of institutions have large numbers of applications. For example, in the Material Sciences domain, of the twelve infrastructures that provided data, the distribution varies between from 0.1 or less patents per 100 employees of the institution (5 RI) to around 0.25 (4 RI) up to 1.0 (1 RI) and even 1.5 (2 RI). A similar distribution could be seen in all scientific domains where more than three institutions were interviewed.

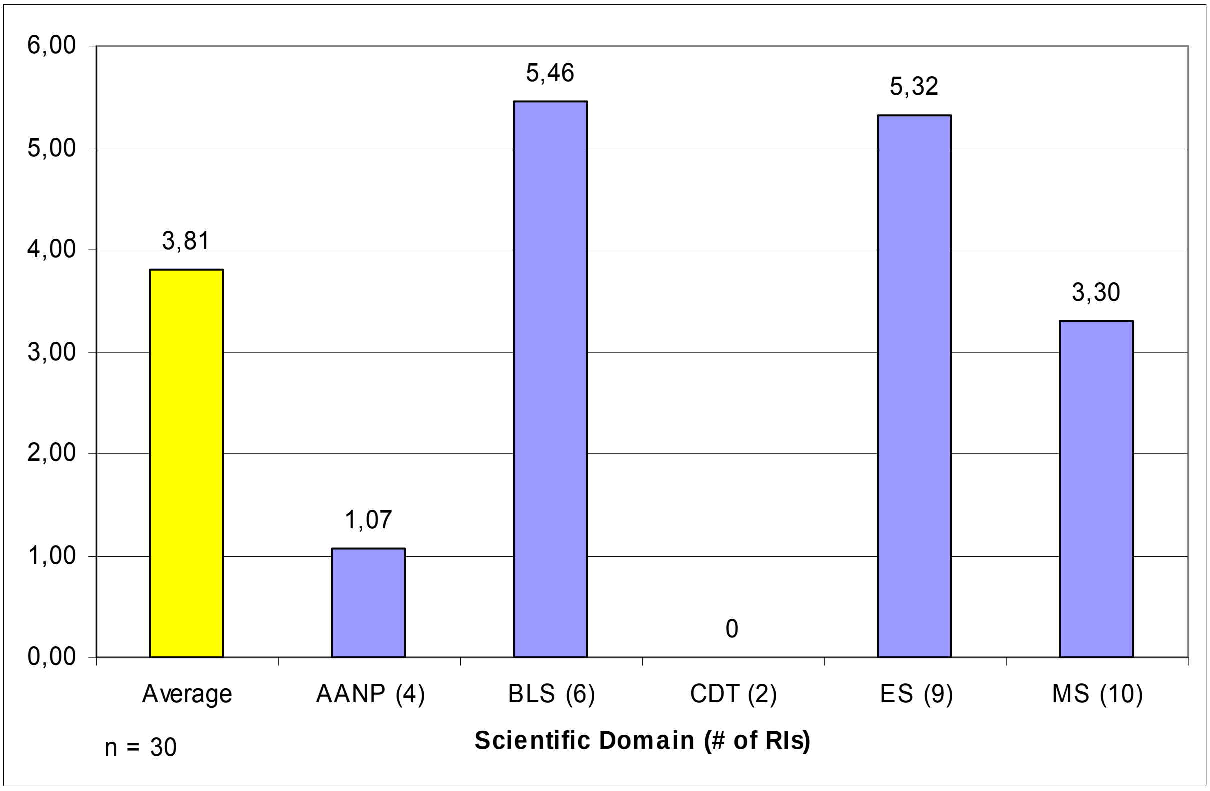

Figure 17 Total Patents held per 100 FTEs by domain

The number of total patents held by the end of 2006 is shown in

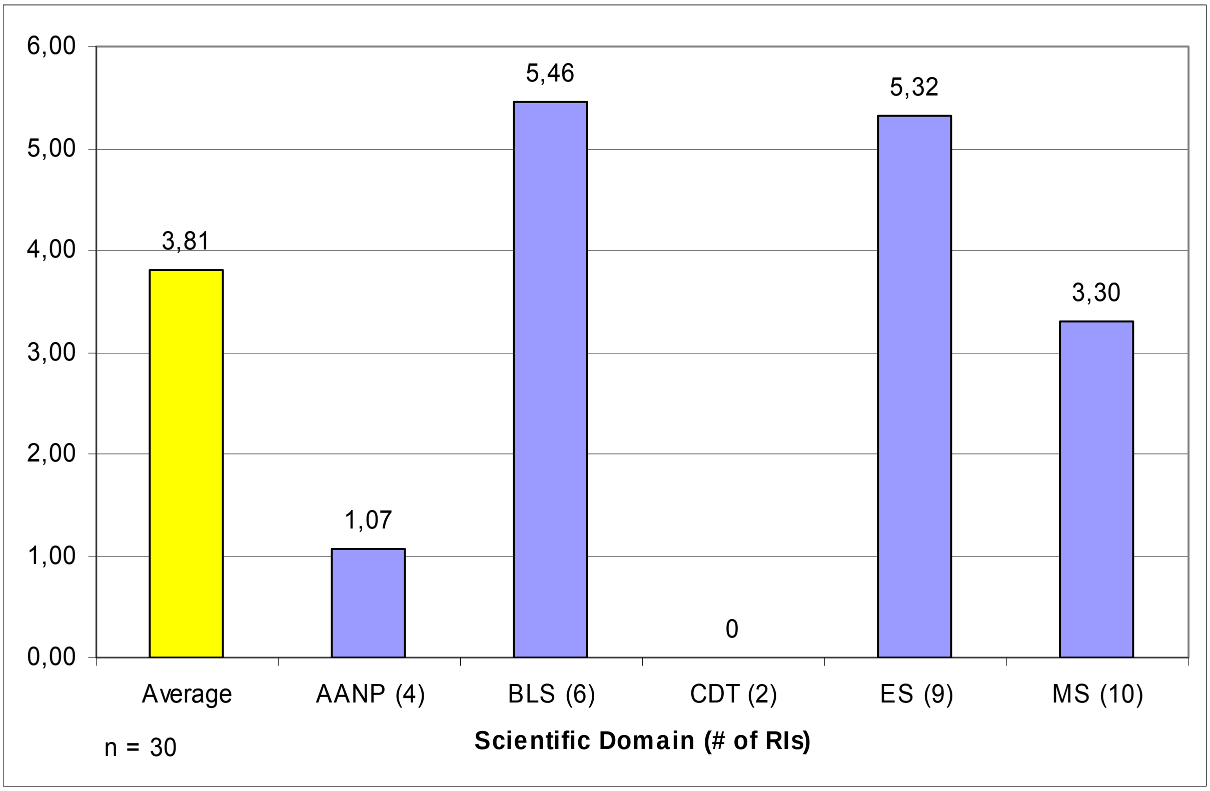

Figure 17. It turns out to be quite different compared to

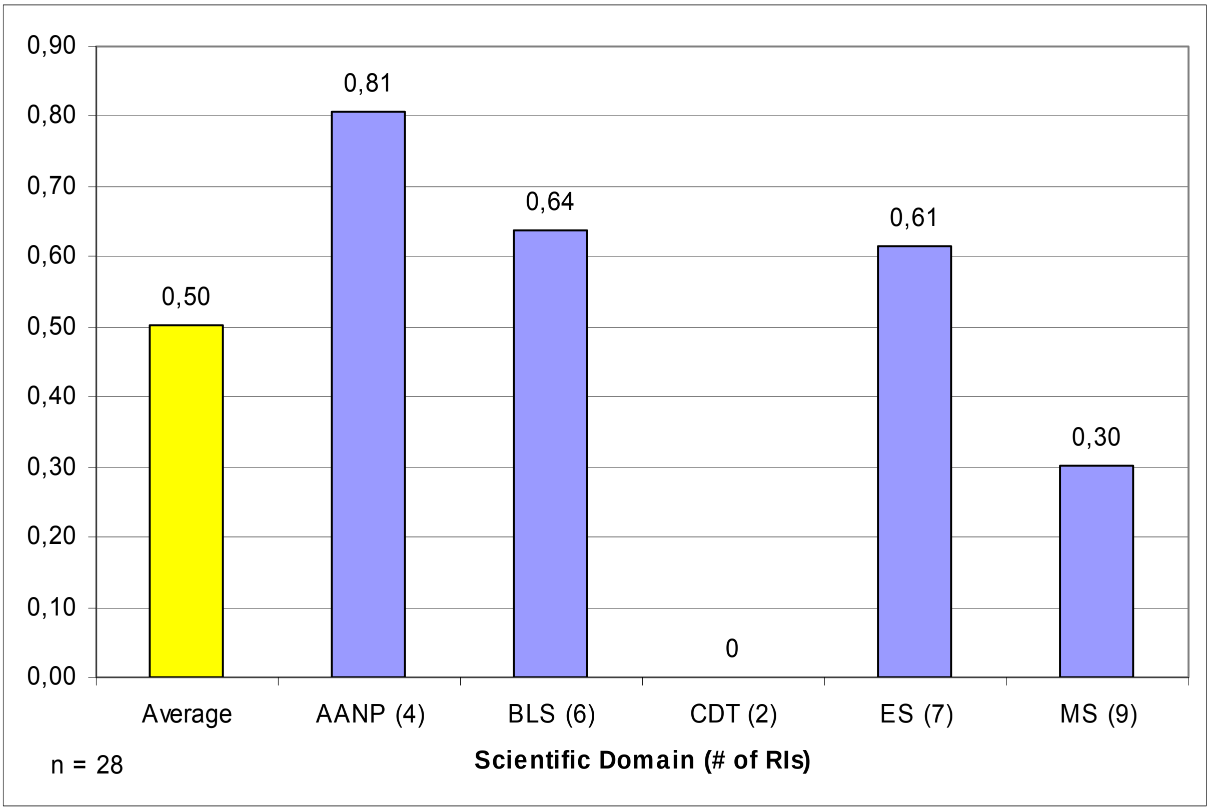

Figure 16 which shows annual patent applications. Here, the BLS domain ranks first, followed by the domain of ES, both above average. The infrastructures of the MS domain follow in the third position, a bit below average. These three domains show the same order as before. But a drastic change is seen in the domain of AANP, now far below average, in marked contrast to its leading position concerning the number of applications. Two explanations for this change in position from the number of applications to the number of total patents are that

- the two largest interviewed infrastructures from the AANP domain obviously do not hold their patents and applications very long, but instead transfer or drop them quickly;
- the small size of the sample within each domain containing ten or less infrastructures means that significant changes within a single institution can lead to dramatic impacts on the whole figure.

The domains less represented in the sample (Energy, CDT and SSH) each hold no patents currently or did not provide information in this area.

A linkage between country and the number of patents held is visible in Figure 18. Out of the countries where several institutions were interviewed and had such information available, Germany has the highest relative possession of intellectual property rights with an average of 7.56 patents held per 100 FTE in its infrastructures. This is followed by the UK with 3.49 patents held per 100 FTE. The other European countries lie below this level with figures between 2.15 and 2.39 patents held per 100 FTE. However, in many countries, only a few institutions were interviewed or able to provide information on this subject. Therefore, these results are not really representative, but it should be noted that in the UK and even more so in Germany, there is a tendency to keep IP rights in the possession of the RIs.

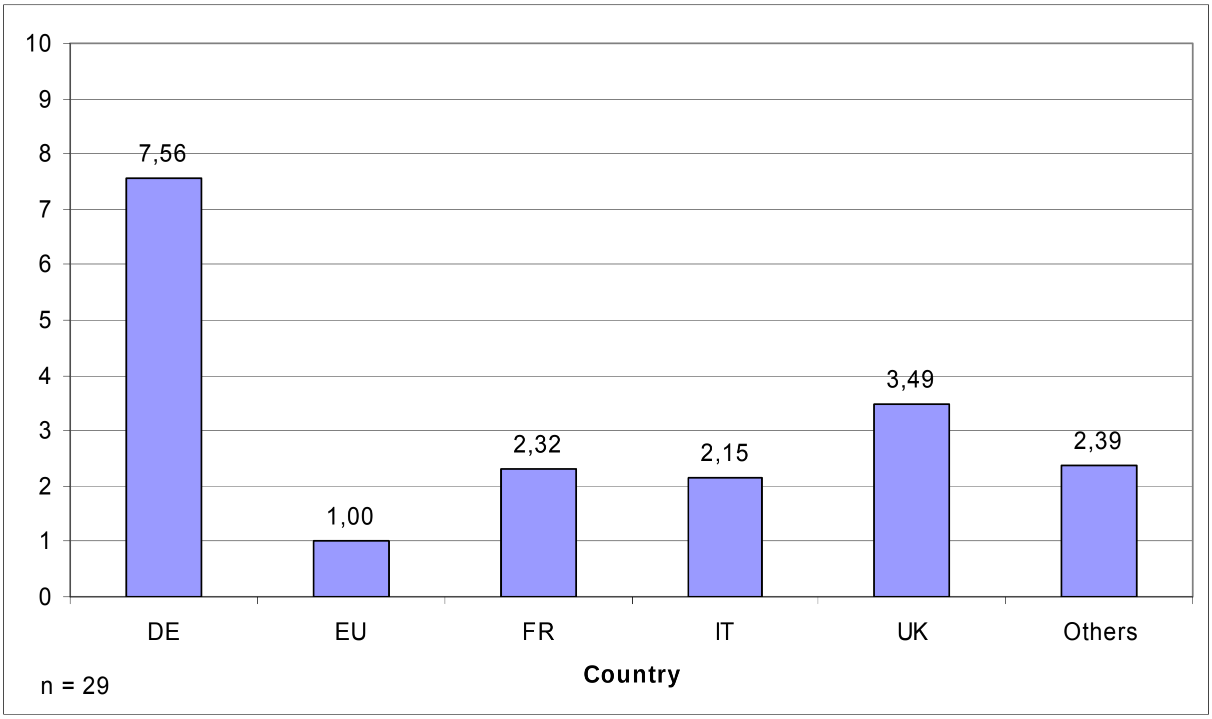

Figure 18 Total Patents per 100 FTE by Country

4.2.6 Licenses & license income

About half of the interviewed RIs made no statement about this topic. Of the 26 infrastructures which were able to provide information, many simply reported that they had not given any licenses**.** On average, just over 20 licenses were given annually in these infrastructures over the last three years - that means only ca. 0.8 licences per infrastructure per year. The individual figures ranged from 0 to 12 licenses per year. In Figure 19, it can be seen that the domains BLS, AANP and ES (the latter only slightly) are above average in giving licenses, while the domain of MS lies below average and the less represented domains have not been active in this field in the last years. All in all, annually just above one new license contract per 1,000 FTE is a really low figure, which indicates that giving licenses is currently not the core route for technology transfer from RIs.

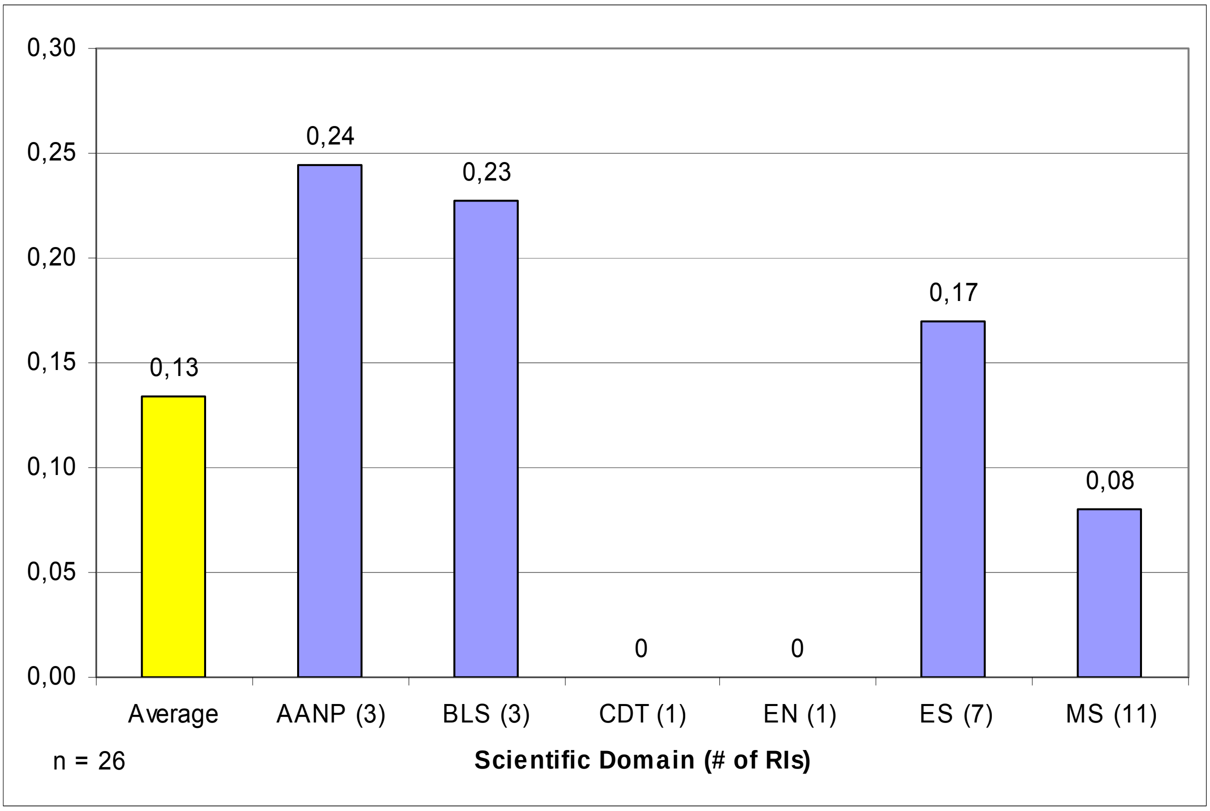

Figure 19 Average Number of Licences given annually per 100 FTE

Looking at the number of total licenses per 100 FTE which are still active in Figure 20, one finds the same picture as in the chart for licenses given annually. The figures are higher by a factor of about 10, which might be taken as an expression for the number of years which the average license is kept alive. A number of 1.53 active licenses per 100 FTE again proves that this channel is not at the heart of transferring technology.

From the small difference between these two figures, it might be deducted that nearly all interviewed infrastructures have not seen many changes in their licensing strategy and approach in the past decade. Another reasonable explanation could be that any such changes, e.g. by new RIs being started etc., are averaged into the individual domains.

An interesting feature is the fact that RIs of the AANP domain do comparatively give many more licenses than their position in Figure 17 showing patents held would seem to indicate. This might either be attributed to know-how licenses without IP rights as a basis or to selling patents and applications instead of keeping them.

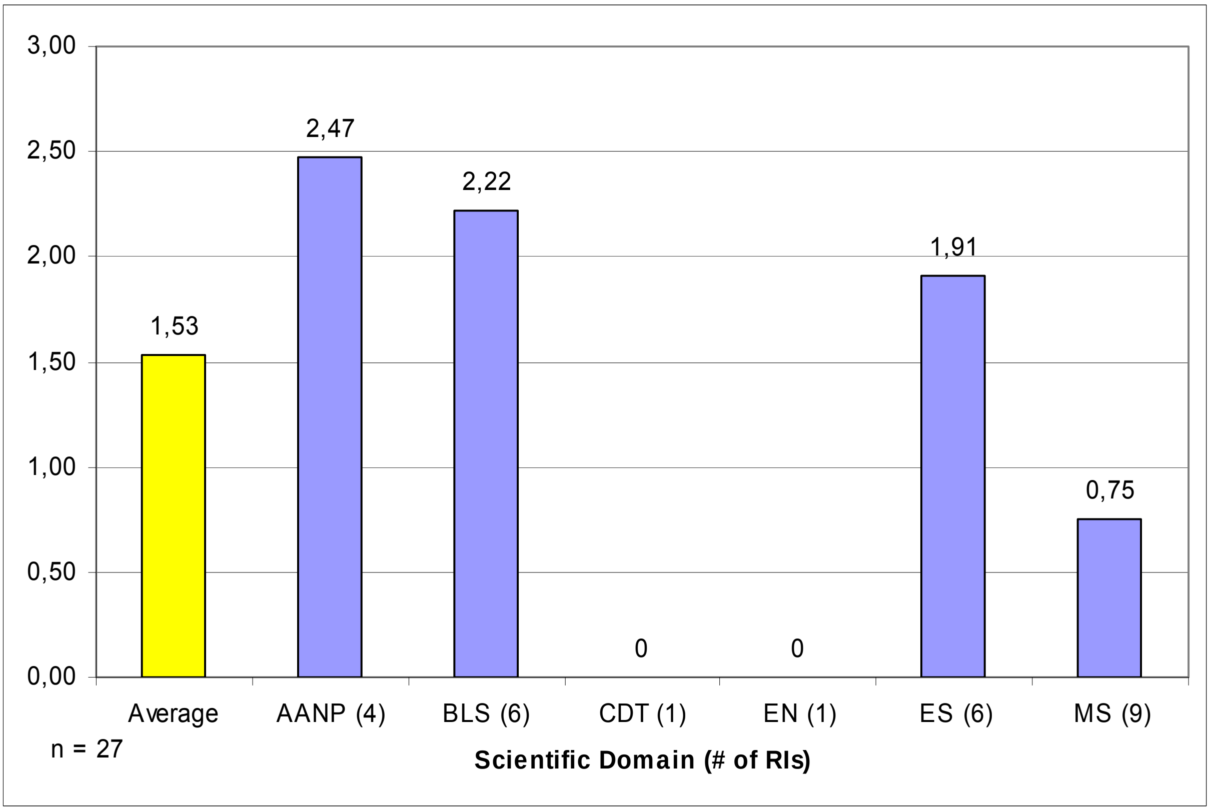

Figure 20 Total Licences active per 100 FTEs

A glance at the income generated annually via licenses in Figure 21 reveals that on average 16,434 € are generated per 100 FTE, this equals 164 € per full time employee. This is far below 1% of the cost for RI personnel, without comprising any other costs. The chart shows that the RIs in the domains of BLS and MS are more successful than others in generating higher royalties with their licenses, while RIs of the MS and AANP domain do not receive much for the use of their IP. License income is apparently a two-tier system. However, one has to consider that only 15 RIs from nine different institutions have reported income at all, while 12 did not receive any royalties. A larger number of interviewed institutions would, thus, surely lead to some shifts in the chart below.

But it should be noted that the AANP domain, whose RIs are ranked first in giving licenses, are by far last in receiving license income. Obviously, the interviewed RIs grant licenses either based on very low rates or even without rates at all and just with small down payments. The low license income at RIs of the MS domain is statistically even more relevant, as they make up the bulk of the interviewed RIs.

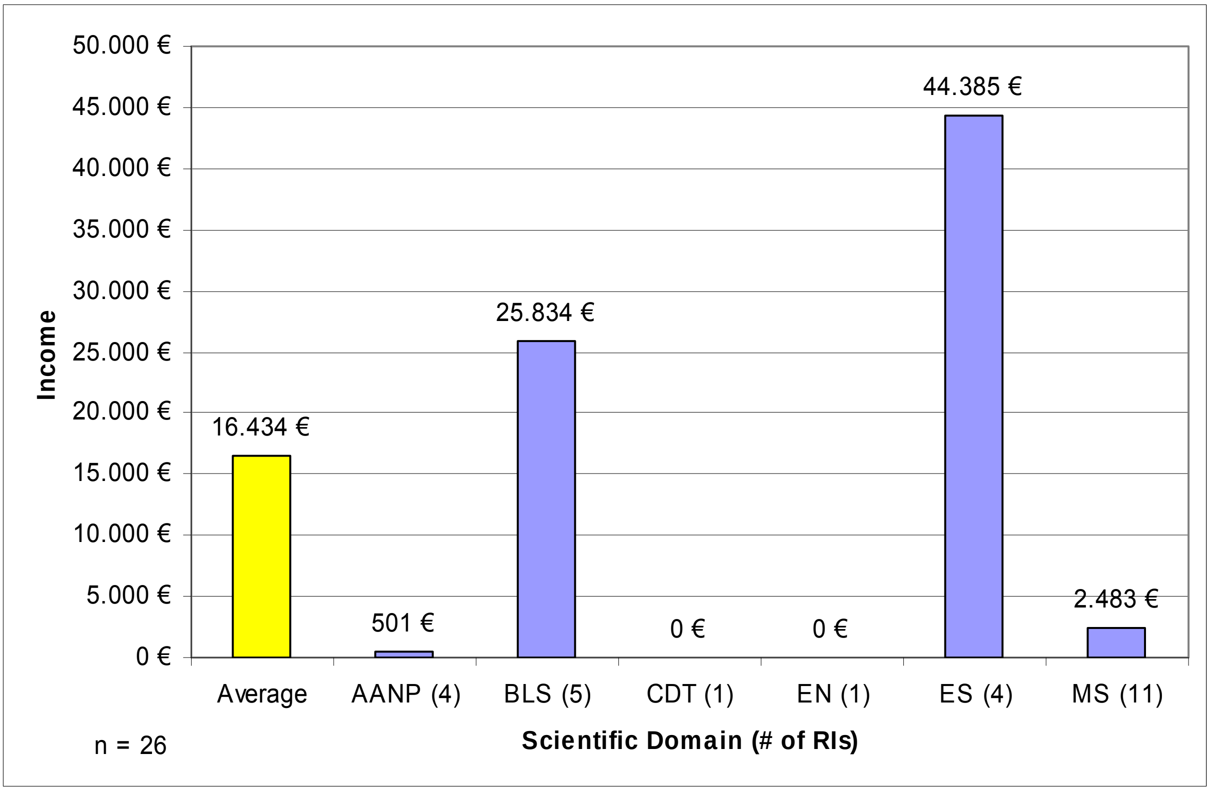

Figure 21 Annual License Income per 100 FTEs

4.2.7 Spin-off companies

Spin-offs could be found in all domains with the exception of CDT, Energy and SSH, which could be explained by the small sample in these domains. 16 out of 51 infrastructures gave no information about this topic, another 12 infrastructures have had no spin-offs yet and 23 had some. The number of spin-offs per institution with infrastructures normally is below ten spin-offs. Only three institutions have more than ten, though one of these reports more than 80 spin-offs.

According to Figure 22, the most spin-off companies per 100 FTE are found in the domain of AANP with 2.74 per 100 FTE, followed by Biomedical and Life Sciences with 1.75 per 100 FTE. All other domains are below the average of 0.95 per 100 FTE. This is significant for the Environmental and Material Sciences domains, but might be attributed to the low number of interviewed RIs for the Energy and CDT domains.

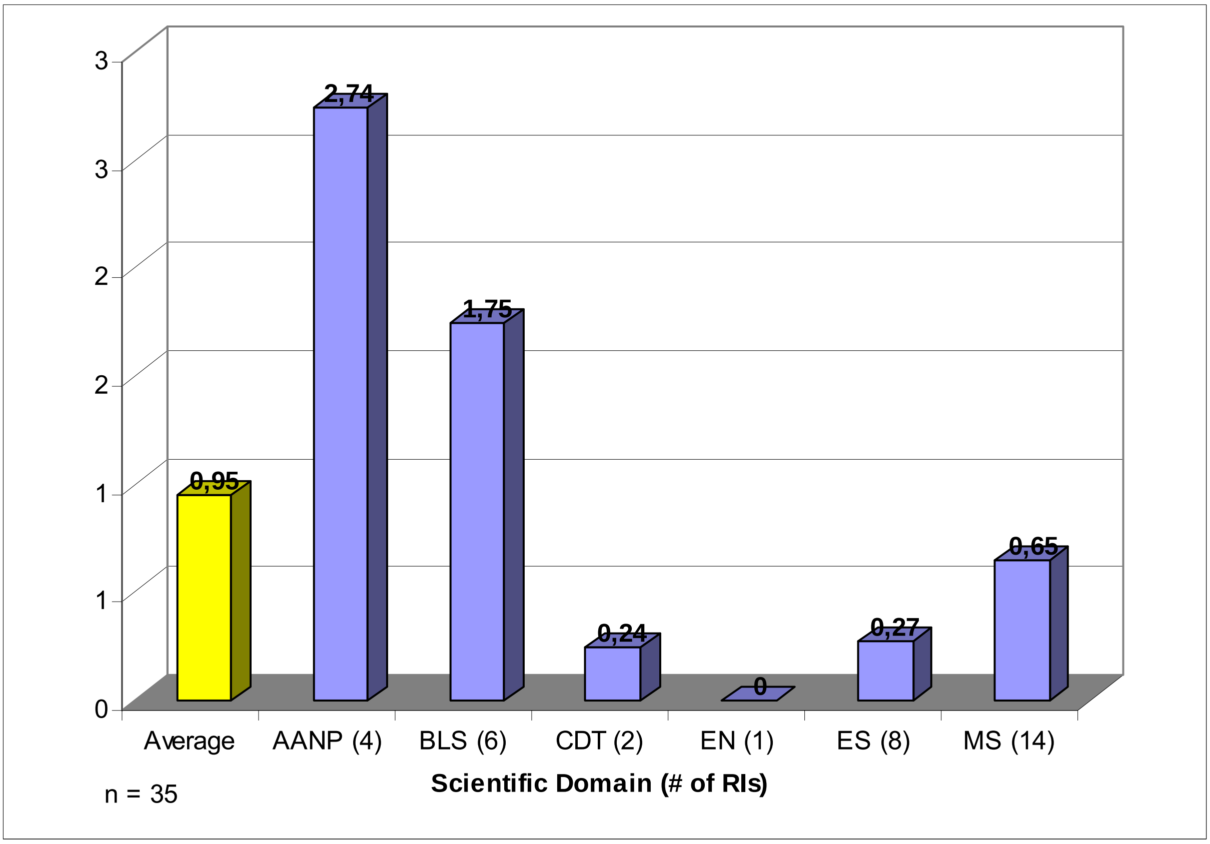

Figure 22 Spin-Offs per 100 FTEs by domain

4.3 Human Resources

The HR section of the questionnaires generated the most discussion during the interviews, as many problems for the RIs are directly related to HR – for example, finding appropriate staff for running the RIs. Problems frequently mentioned were low salaries compared to industry, the high number of fixed termed contracts vs. permanent contracts, and the related difficulties in recruiting staff. This seems to be predominantly an issue in public research organisations.

No notable programs for the exchange of staff between RIs and industrial partners/companies were found during the ERID-Watch Interviews. Once someone has left academia for industry, they usually do not return. The higher salaries in industry might be one of the reasons, but the different focuses of industrial vs. academic scientific work are also perceived as playing an important role. While in academic institutions, an ongoing update on the latest scientific developments via information exchanges with colleagues is part of the daily work, for most industrial scientists, their focus has changed and they are no longer part of this process.

The majority of the interviewed RIs offer additional training for their staff, including soft skills training.

The average interviewed institution has approximately 744 staff members (based on the responses received from 43 infrastructures from 31 institutes). The largest numbers of employees can be found in the scientific domains of Material Sciences; Environmental Sciences; and Astronomy, Astrophysics, Nuclear & Particle Physics. The highest number of

employees per institute is found in Computation and Data Treatment; Astronomy, Astrophysics, Nuclear & Particle Physics; and Environmental Sciences.
65% of the staff of the interviewed institutions has permanent contracts. The two scientific domains of Material Sciences and Astronomy, Astrophysics, Nuclear & Particle Physics lie significantly above this with reported values of 89% and 72%, respectively.

4.3.1 Origin, exchange and training of staff

Human Resources administration is a task carried out at the institutional level; at least this was the case for all institutes who could answer this part of the interview. This can make it difficult to get information about the number of staff working for one RI as only few institutes make separations between the different RIs. Therefore, this chapter will also focus on the institutional level, aside from the average number of staff per infrastructure, which will be taken into account for comparative purposes below. The recruitment of scientific personnel in nearly all institutions is done in cooperation between the Human Resources department (or in smaller institutions between the administration) and scientific groups – depending on the level of the position with scientific committees or group leaders.
Data on the national origin of staff were largely unavailable. Only a few could provide numbers. Among them were most of the EIROFORUM members, as they are concerned with a fair origin of staff from their member countries. However, since this information was only available from such a small number of RIs and even these are primarily a special kind of RI, an analysis of these data does not make sense, as it is not representative at all.
No notable programs for the exchange of industrial and public staff members could be found during the interviews. Some institutions expressed no interest in this type of employee exchange, while others had begun thinking about a way to handle an exchange, but had yet to develop a special programme for it. At the moment, most institutions do not gather information about whether their staff members' previous employer was in the industrial or public sector. There data were mainly estimated by the interviewees. In the scientific area, it was estimated that only a very small percentage had industrial experiences – mainly the idea predominated that once someone has left academia for industry, they do not return. The different focuses of industrial vs. academic scientific work are perceived as the explanation for this. While in academic institutions, an ongoing update on the latest scientific developments via information exchanges with colleagues is part of the daily work, for most industrial scientists, their focus has changed and they are no longer part of this process. Only among the administrative staff was there on average more experience within industry.
The majority of the interviewed RIs offer training for their staff – some in cooperation with external organisations. The smaller institutions (with less than 100 staff members) do not commonly organise training courses, independent of scientific domain or country.
Education of non-scientific staff, for example gardeners, is only offered by 13 of the interviewed RIs.

4.3.2 Average number of employees

Wherever possible, the number of employees was gathered at the RI level as well as at the institutional level. Ten RIs provided no information on the number of their employees. Figure 23 and Figure 24 refer to the sizes of the institutes to which the 43 responding RIs belong.

As can be seen in Figure 23, the majority of RIs belongs either to an institution of a size between 100-499 employees (32%) or to an institution with more than 1000 employees (30%). The remaining number of RIs is divided evenly between institutions with less than 100 employees and institutions with 500-999 employees, with 19% each.

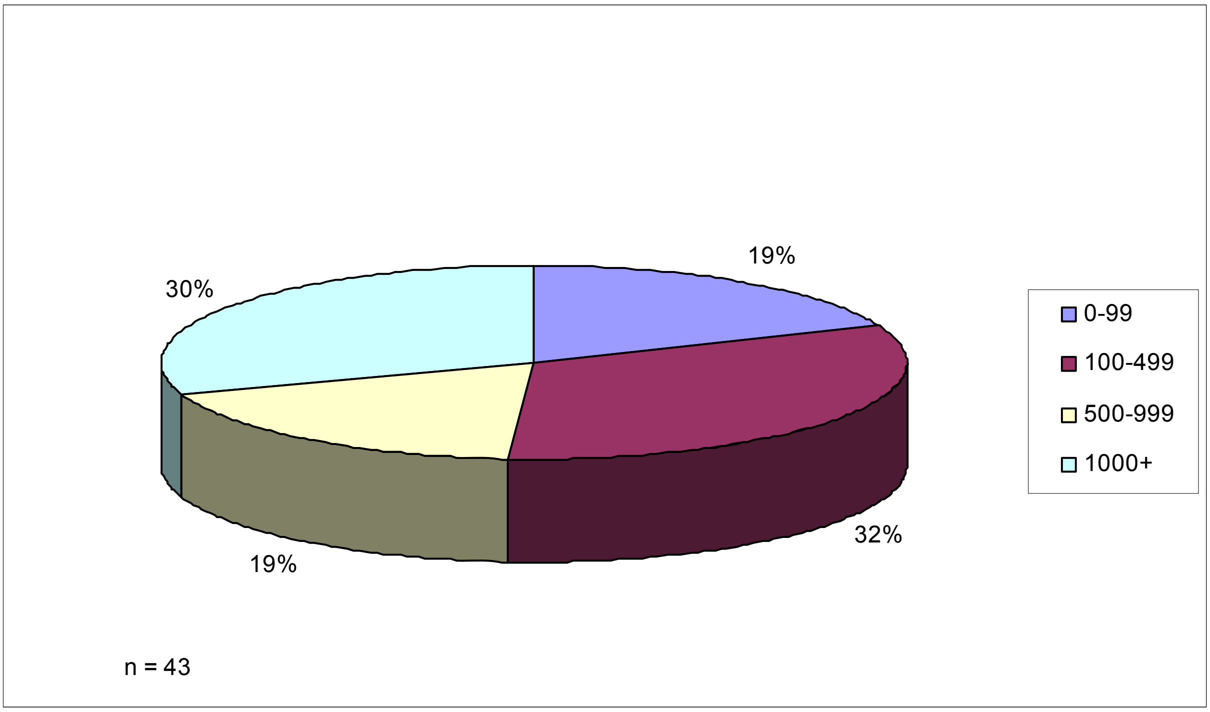

Figure 23 Number of FTEs at Interviewed Research Infrastructures

Figure 24 shows the institute sizes across the scientific domain. Again, for each analysed RI, the size of the institute was used to tabulate the data. The mean average of the number of employees per scientific domain is 5777.

The scientific domains of MS, ES, and AANP, where the huge bulk of employees can be found, lie well above this average, with MS leading the field with 9022 employees, followed by ES with 8133, and AANP with 6725.

Although MS shows the highest total number of employees, it is next to last in the count of which scientific domain shows the highest number of employees per institute. Here the ranking from highest number of employees to lowest per institute is:

CDT: 1823
AANP: 1345
ES: 739
BLS: 698
MS: 564
EN: 428 (only one institute).

The high number of employees per institute in the domain CDT is not necessarily representative, as the data are heavily biased by one large institution that has a staff of 2500, of which only a very small part are occupied with the RI, while the others are doing services for other public institutions.
Overall, the EIROFORUM members again influence the sample: They have the largest numbers of staff members per institution and 6 of the 7 EIROFORUM members belong to the AANP domain.

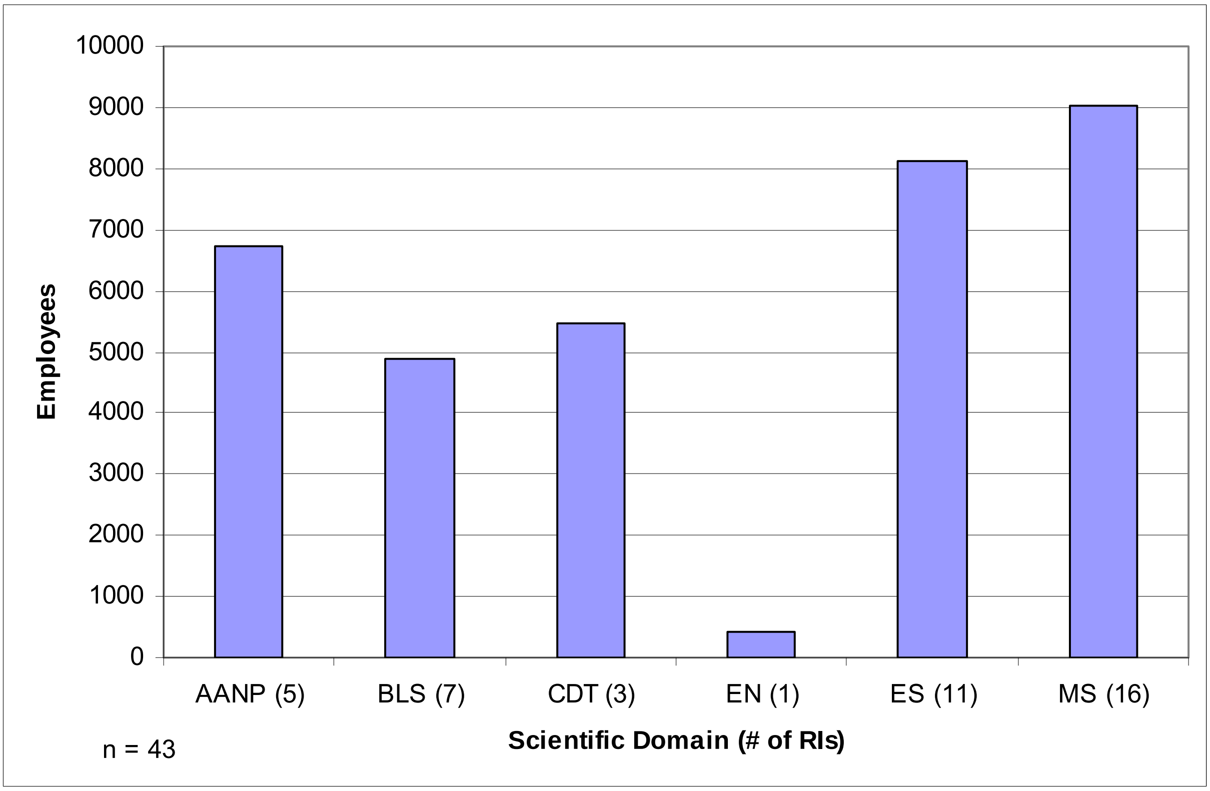

Figure 24 Total FTEs at Interviewed Research Infrastructures by Scientific Domain

An average interviewed institution has approximately 744 staff members (based on 43 infrastructures from 31 institutes).

4.3.3 Type of employment contracts

Figure 25 shows the types of employment contracts. 65% of the staff of the interviewed institutions has permanent contracts. The two scientific domains of Material Sciences and Astronomy, Astrophysics, Nuclear & Particle Physics lie significantly above this value with 89% and 72%, respectively, as can be seen in Figure 26. Freelance contracts were only reported in the Biomedical and Life Sciences and the Environmental Sciences.

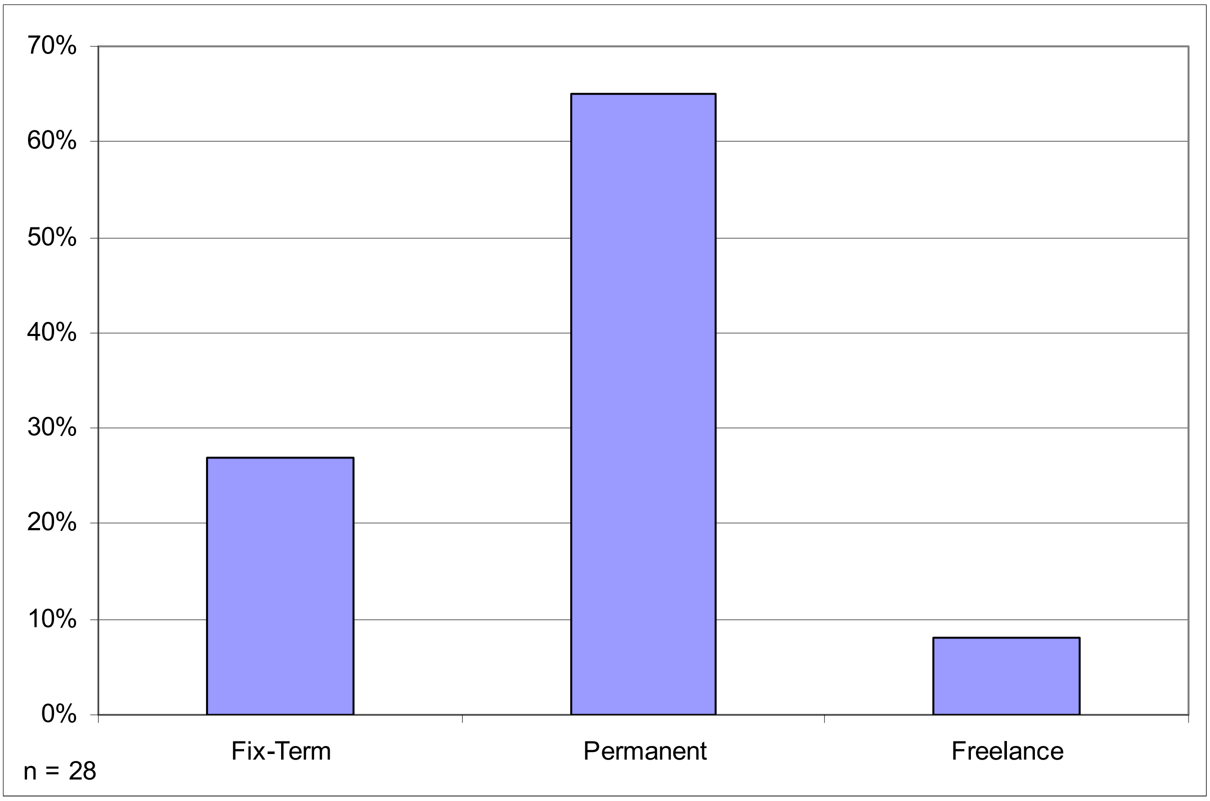

Figure 25 Types of Employment Contracts

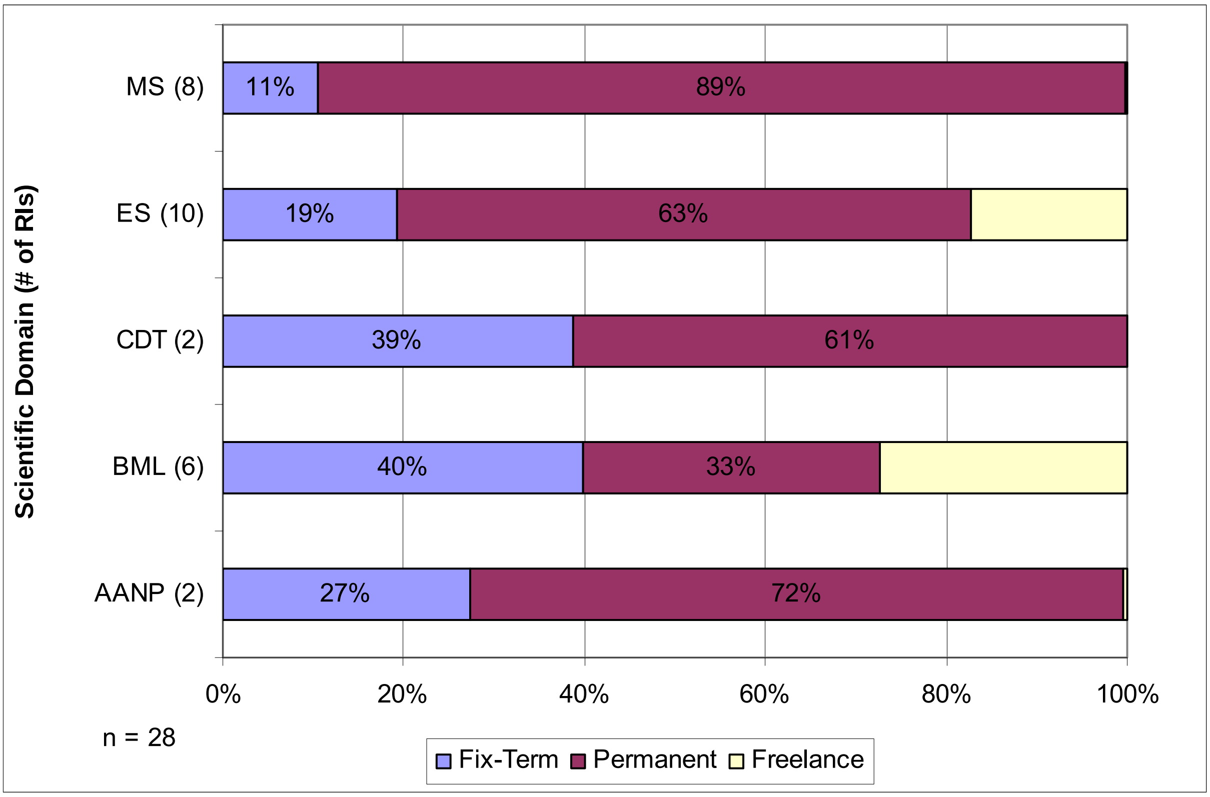

Figure 26 Types of Employment Contracts by Scientific Domain

One novel approach to contracts should be mentioned that can be seen as either an outstanding positive or negative example, depending on one's point of view. In one of the interviewed institutions, a policy of having less than 11% permanent contracts is used. All other contracts are maximum 9-year termed contracts, separated into several smaller contracts (3/3/3 or 4/5). This policy is used for all staff members, including the administration. This ensures an exchange of personnel with other organisations and countries – the excellently educated staff members return to their home countries and spread their knowledge. On the other hand, this policy was mentioned by the institution as problematic – some people may avoid seeking employment with this institution even though they would be a benefit for the staff. Moreover, people with outstanding experience in very special areas are difficult to replace after nine years.
Another outstanding example is the staff exchange between two very similar institutions in two different countries. The exchanged staff members spend a special time in the partner institution. Through this exchange, the staffs in both institutions are kept at similar experience levels, and best practices flow directly back and forth between the institutions of the two countries.

4.3.4 Problems and Consequences

Three major problems were often mentioned during interviews:
- Fixed-term contracts
- Low salaries
- Difficulties in finding appropriate staff

The problems may occur as single problems, but may also be connected with each other. One example of fix-term contract problems was already mentioned above. In Germany, the problem of fixed-term contracts was also frequently listed, as often only two- or three-year contracts are given. This can present a major issue, especially when running a complicated infrastructure. In one special case, it was mentioned that the necessary education to use the infrastructure takes nearly two years. Furthermore, in this case, the salary levels were clearly perceived as a disadvantage – the institution was concerned about the future quality of their infrastructure. It was generally agreed that it is especially hard to find senior personnel with fixed-term contracts.

In addition to the impression that salaries are generally too low, it was noted that salaries in nearly all institutions are lower then in a comparable industry position. Within some countries where, for example, the employment rate is comparably high, this was mentioned as problematic on the one hand. On the other hand, it was argued that some people choose the lower paid academic job, precisely because it comes with greater freedom in designing one's own work, where the salary is only a secondary consideration. But this becomes problematic in countries or cities where the living costs are so high that choosing an academic career may be a real financial problem during the first years. But nearly all interviewees agreed that the level of salaries is another major reason why the general rule holds that "once industry, always industry". With only one or two exceptions, no research institution is able to maintain the same salary level with industry. Even within Europe, different salary levels within the academic world constitute a problem – national levels can differ quite a bit, and only a few researchers want to go back to a country where they earn less. Some interviewees were concerned that the ever-widening gap between industrial and academic salaries might endanger the quality of future science.

It was also argued that it is difficult to get senior or more experienced staff even from other European countries because of the perceived negative effects on pensions and retirement plans.

Some institutions have made some attempts to solve some of these problems: in order to attract non-national staff members, one institution pays an additional 450€/month for short term contracts, while another institution offers more than a third more vacation days as a small compensation for lower salaries. Others are rewarding excellence or paying other allowances to offer more competitive salaries to their staff.

4.4 Case Study on Industrial Usage of Synchrotron Radiation

This study was designed as a standalone report. Main Conclusions and Recommendations of the Study are integrated in the main document of the Final Report.

4.4.1 Executive Summary

4.4.1.1 Study Intent

The needs of industrial users at highly specialized research infrastructures like synchrotrons were of special interest to us. We wanted to examine how different institutes handle the challenge of accommodating varying industrial needs in a general framework of more basic than applied research. In the practice study on Industrial Usage of Synchrotrons, we wanted to focus specifically on how industrial usage of synchrotron radiation is organized at a number of European synchrotrons. For that purpose, we set out to interview ten institutes in Europe plus one from outside Europe, as well as a number of industrial users of the synchrotrons.

4.4.1.2 Participating Synchrotrons

According to lightsources.org, there were 21 lightsources in Europe when we began the study[1], not all of which are synchrotrons. Of the synchrotrons, we ultimately interviewed the nine institutes described below. The rest had either no industrial users, were too small, had not started user operation long enough or could not participate due to their own organisational obligations. The complete list that served as a basis for the selection of interview partners and more details can be found in Section 4.4.3.

Nine European and one American Synchrotron participated in the study:

- Berliner Elektronenspeicherring - Gesellschaft für Synchrotronstrahlung m.b.H (Bessy), **Germany**,
- Diamond Light Source Ltd. (Diamond), **UK**
- Synchrotron Light Source (SRS), Daresbury, **UK**, closed on August 4th 2008
- Sincrotrone Trieste, S.C.p.A. (Elettra), **Italy**
- European Synchrotron Radiation Facility (ESRF), **France**
- Hamburger Synchrotronstrahlungslabor (HASYLAB) at Deutsches Elektronen-Synchrotron (DESY), a Research Centre of the Helmholtz Association, **Germany**
- MAX-Lab, Lund University (MAX-Lab), **Sweden**
- Soleil Synchrotron (Soleil), **France**
- Swiss Light Source (SLS) at Paul-Scherrer-Institut (PSI), **Switzerland**
- National Synchrotron Light Source (NSLS) at Brookhaven National Laboratory, **USA**

[1] Lightsources.org lists in fact 26 lightsources for Europe, including three from Russia and two from Ukraine.

4.4.1.3 Main Conclusions

4.4.1.3.1 Price System and Annual Turnover

All synchrotrons make a distinction between published and proprietary research.
Published research is generally free.
The prices for one hour of beamtime range from 100€ to 930€ and are not always based upon a detailed calculation of the real costs.
The average sales price is 313€[2] .
Half of the synchrotrons named their prices for one hour of service. These prices range from € 100 to € 175.
Three institutes charge additional or higher fees for Mail-In Service in the field of Protein Crystallography.
The average annual turnover from industrial use at these synchrotrons ranges from € 50.000 to € 2.5 million.
The institute with the largest annual turnover earns as much as all the rest of the compared synchrotrons combined. This institute also has the highest number of users and staff.
Average annual turnover of seven compared institutes lies around € 659.286.

4.4.1.3.2 Industrial Usage and Customer Fields

Across the synchrotrons there is often a wide difference in the amount of industrial usage.

Beamtime hours annually given to industry ranged from 219 to 3700; this equals a percentage of 0,2% to 12%.

The number of users ranges from 4 to 50 per year, and often these users visit more than once.

All but one synchrotron reported that the majority of its customers come form the pharmaceutical area. At this one exception, most customers came from the field of “Chemistry and Energy”.

For the future, all but two institutes expect an increase in industrial users, but hardly anybody expects an increase above 10% of the total usage.

All agree that, seen globally, the industrial usage of synchrotrons will experience an increase.

Life Sciences, closely followed by Chemistry and Energy, are seen as the fields with the most potential for the future. One synchrotron sees the greatest potential relevance in Electronics.

4.4.1.3.3 Industry Service

All European Synchrotrons offer rapid access for industrial customers.

[2] Additional information on the calculation of the average: two institutes gave a lowest and highest price, for those we averaged a price out of the lowest and the highest without knowledge of how many hours were in fact sold for the more “expensive” price, because that information was not given. The others stated an average price themselves.

The U.S.-based NSLS is in the process of implementing this service, also. It is interesting that although everyone sees rapid access as an important demand of industrial customers, the NSLS already enjoys a high usage rate by industrial customers (5.6%) without having rapid access implemented yet.

Being able to offer service is generally regarded as most important, especially if one wants to draw in more local small to medium enterprises (SMEs).

Drawing in more (local) SMEs was explicitly stated as a goal in several cases.

Service deemed necessary includes general assistance by a beamline scientist, experimental setup, and analysis of the measurement results.

Dedicated beamlines for industry are not very widespread and the opinions on them vary.

Most institutes do not have a beamline established exclusively for industrial use, though in some cases this is the *de facto* situation, as only industry uses a certain beamline. The study found one model where a beamline is financed by industry and a research institute. This model also exists at the NSLS in the form of the Participating Research Teams (PRTs).

Two thirds of the institutes have special service groups for industry that liaise between scientists and industry. In one case, an external company was founded to better service the larger, long-term customers.

4.4.1.3.4 Marketing

We found that most institutes mix an indirect with a direct marketing approach:

The indirect approach is evident in the institutes' emphasizing how important networking and going to scientific conferences is. The industrial users become aware of the synchrotrons via their scientific merits and can tap into the excellent research programmes that are offered. In general, high visibility and a good reputation are assumed to increase industrial usage.

But many institutes also seem to have reached a point where they set out to try a more direct method of marketing synchrotron radiation in the following ways:

1. Starting with a survey of the market and identifying possible customers and their needs.
2. Trying to make their product offer more transparent.
3. Developing strategies to communicate their product offer to a designated clientele of potential customers. Among these strategies are informative and attractive websites, product catalogues, special industry service groups, flyers and free tests.
4. Enlarging the service connected with the offer of synchrotron radiation. These services should include the permanent presence of a beamline scientist, offering experimental set-up for the uninitiated, and carrying out the analysis of the data.
5. Trying to solve the problem of communicating the possibilities of synchrotron radiation and better understand the needs of industrial users. For this, it is important to have

specialized members of a service group, or at least someone who has the time and capability to "speak the language" of both the scientist and of the customer.

In the selling of synchrotron radiation, it seems especially crucial to recognize analogies between fields to be able to offer the right solution. Thus, it is vital that experts from different fields work together: the scientists with the in depth knowledge of the methodological possibilities and the marketing and business people to mould it into a sellable product geared toward the needs of the market.
This conclusion is in accordance with the general perception that the marketing of beamlines has to be a combined effort by people from the marketing/business sector and scientists, or through a combination of these skills by hiring people with skills from both fields in their profile who can act as liaisons between science and business.

4.4.1.4 Main Recommendations

R1: Have a Service Group or at least a designated person for Industrial Liaison to secure a communication channel between industry and science

R2: Use uniform statistics for recording beamtime, type of use, users and customer fields to achieve more transparency.

R3: Offer fast and easy access for industrial customers.

R4: Perform a market analysis to be able to differentiate between the different needs of different customers.

R5: Build a unique profile offering modular, fine-tuned service geared towards customer needs.

R6: Continue and expand networking at conferences.

R7: Combine an indirect marketing approach with a direct approach according to one's own profile.

R8: Network with other synchrotrons.

4.4.2 Background/Methodology

The time basis for the study's questioning was the period from 2005 – 2007. We used a questionnaire, in which we tried to cover the following topics:

- Overall general parameters of the institutes questioned, such as size, budget and purpose of the institute; size, type and age of the lightsource; number of total beamlines; number of beamlines used mainly by industry (if any); and number of staff dedicated to industry service

- Details of the processes involved, such as the organisation of schedules for allocation of beamtime; included services; documents involved; registration process for beamline application; differences between applications made by researchers vs. industry; marketing instruments to acquire more industrial users; and prices depending on nature of usage (e.g. published or proprietary)

For this, we interviewed supervisors and staff from the following departments:

- administration
- research
- directorate
- technology transfer/ industry group
- user contact

The questionnaires contained “numbers and facts” questions as well as evaluative questions. For the latter, we used an evaluation scheme[3] that can be found in **Erreur ! Source du renvoi introuvable.**. A few questions were aimed solely at obtaining the opinions of the people that have been handling and planning industrial usage at the synchrotrons (often for quite a while). We try to give a mirror of these assessments and views on the perspective and nature of industrial usage throughout the study.
We also intended to identify a number of industrial users of each synchrotron who would be willing to fill out a short questionnaire about their perspectives on what a synchrotron should provide in terms of service for industrial users. However, most of the synchrotrons were very hesitant to name any industrial users or to ask their users to go to the trouble of filling out the questionnaire. In the end, two synchrotrons were able to provide us with some company names, which we interviewed in order to obtain at least some examples of industrial views. Due to the very limited number of interviewed companies, their input is not representative or quantitative, but much more of a qualitative nature.

4.4.3 Selection of Synchrotrons to be interviewed

At the time of this Case Study, lightsources.org lists 69 lightsources worldwide, 21 of which are in Europe[4], and not all of which are synchrotrons. From these, we ultimately interviewed the nine institutes described below. The complete list that served as a basis for the selection of interview partners and more details on the reasons for choosing specific institutes can be found in the Appendix, Chapter **Erreur ! Source du renvoi introuvable.**.

[3] Evaluation numbers from our evaluation scheme map on textual description as follows: 1 = “least important”; 2 = “not very important”; 3 = “moderately important”; 4 = “important”; 5 = “very important”; 6 = “most important”

[4] Lightsources.org lists in fact 26 lightsources for Europe, including three from Russia and two from Ukraine.

- **Berliner Elektronenspeicherring - Gesellschaft für Synchrotronstrahlung m.b.H (Bessy)**, Germany,
  Staff: 227
  Beamlines: 27
  Beamtime Users: ca. 1300 / year
- **Diamond**, UK
  Staff: 354
  Beamlines: 7 momentarily operational; 22 in Phase II
  Beamtime Users: not yet applicable
- **Synchrotron Light Source (SRS)**, Daresbury, UK, closed on August 4th 2008
  Staff: 114
  Beamlines: 27
  Beamtime Users: 1444 / year
- **Elettra**, Italy
  Staff: 310
  Beamtime Users: > 1000 / year
  Beamlines: 24
- **European Synchrotron Radiation Facility (ESRF)**, France
  Staff: 600
  Beamtime Users: 6000 / year
  Beamlines: 31
- **Hamburger Synchrotronstrahlungslabor (HASYLAB)** at Deutsches Elektronen-Synchrotron (DESY) a Research Centre of the Helmholtz Association
  Staff: 85 (HASYLAB), 1900 (DESY)
  Beamlines: 33
  Beamtime Users: 2200 / year
- **MAX-Lab**, Lund University, Sweden
  National Electron Accelerator Laboratory for
  Synchrotron Radiation Research, Nuclear Physics and Accelerator Physics
  Staff: 80
  Beamlines: 17
  Beamtime Users: 700
- **Soleil**, France
  Staff: 400
  Beamlines: 12
  Beamtime Users: 2000 / year
- **Swiss Light Source (SLS)** at Paul-Scherrer-Institut (PSI), Switzerland
  Staff: 150 (SLS), 1350 (PSI)
  Beamlines: 13
  Beamtime Users: 1200 / year
- **National Synchrotron Light Source (NSLS)** at Brookhaven National Laboratory (BNL), Upton, New York, USA
  Staff: 214 (NSLS), 2600 (BNL)
  Beamlines: 67
  Beamtime Users: 2200 / year

We added the National Synchrotron Light Source (NSLS) for a transatlantic comparison. At the NSLS, an internal report has been compiled by NSLS staff about industrial usage, wherein data relating to industrial users have been compared for Fiscal Year 2006. Much of the NSLS data was taken from this report.

The NSLS seemed a good institute for comparison. We knew they had been undertaking similar studies of comparing synchrotrons and had also prepared the aforementioned paper on industrial usage at their own institute in advance of the construction of NSLSII, so we expected an awareness and interest in the topic of our study.

When we compare figures across the ten synchrotrons we studied, we treat the NSLS as just one of ten. In the section “Summary of Industrial Usage at the NSLS,” we summarize the results from our American interview partners.

Figure 27 and Figure 28 show the numbers of Staff and Users across all synchrotrons, respectively.

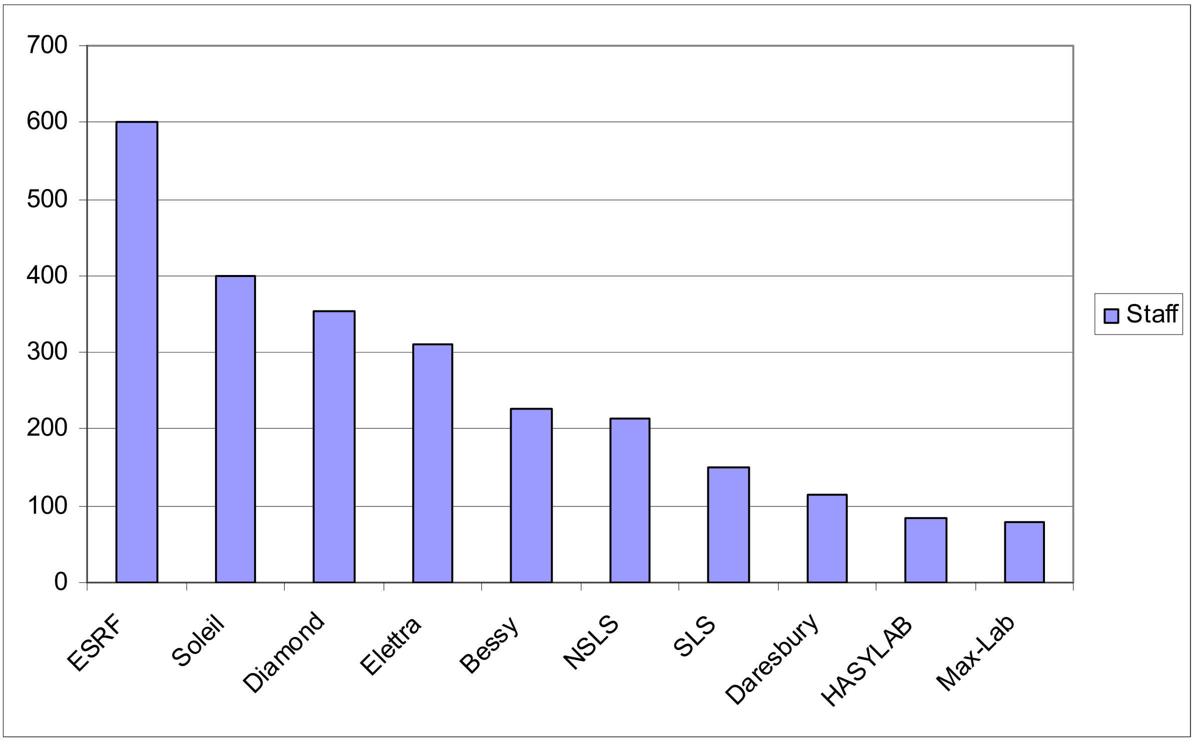

Figure 27 Staff

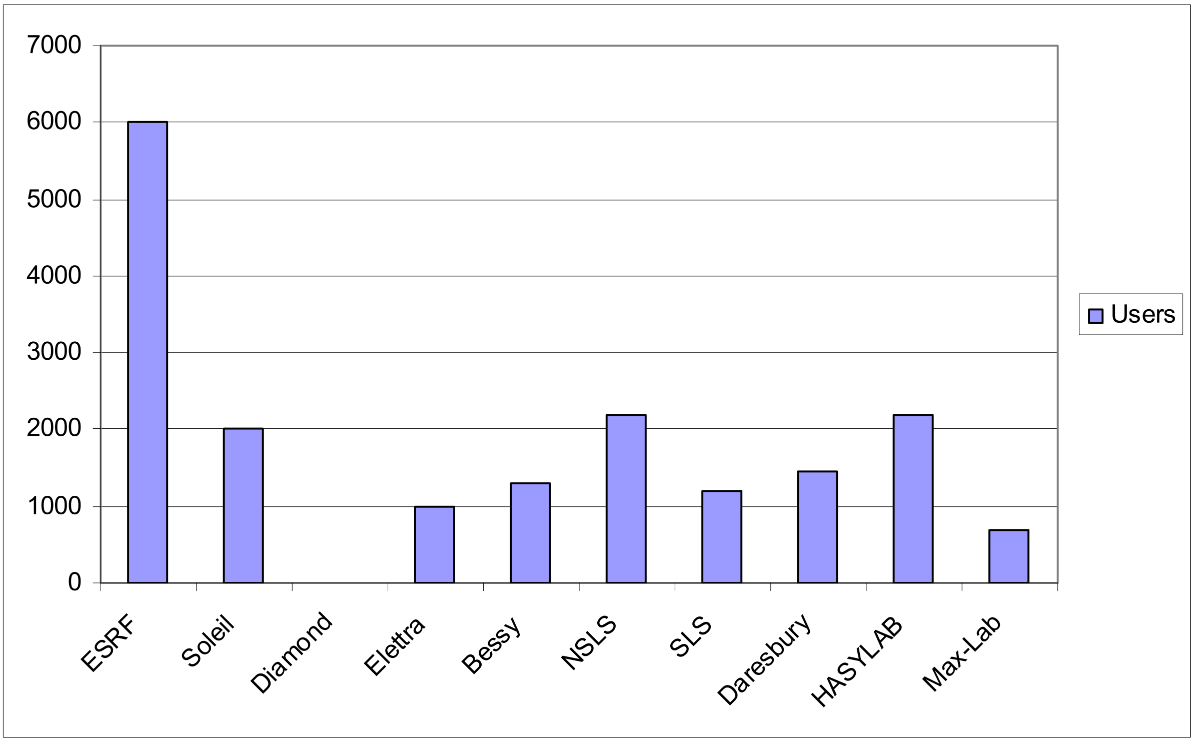

Figure 28 Users

4.4.4 Results from the Questionnaires

4.4.4.1 General administrative framework and obligations

To get an idea of the general setting and conditions surrounding industrial beamtime usage, we asked a few questions about policy and politics. Of the ten interviewed synchrotrons, three are embedded into a larger surrounding institute.

4.4.4.1.1 Beamtime policy for industry

It turned out that no synchrotron has a general requirement that a certain minimum amount of beamtime must be granted to industry.
Though half of the synchrotrons have limited beamtime usage for industry, only three of those set an explicit limit of 10%. One institute employs a rule that limits industrial usage of a single beamline to 20%, and two have similar rules that limit the usage on individual beamlines to 30%. Four synchrotrons have set no limit for beamtime usage by industry.
Six institutes state that there is no rule that some beamlines may only be used up to a certain percentage by industry.
Usually this policy has remained the same throughout the last three years; in one case the policy changed to a less strict limitation of beamtime for industry.

Dedicated beamlines for industry are not very widespread.
Six institutes do **not** have any dedicated beamlines for industry.
One synchrotron has two dedicated microfabrication beamlines and another for industrial usage of Protein Crystallography.

Across all institutes, there is the perception that the government rates industrial usage as highly important (6)[5].
The management of the institution is perceived to rate it on average as very important (5.2), while the employees are believed to rate it on average as important (4.2).

4.4.4.1.2 Helping and Blocking Factors

Below are a few suggested examples of what the individual institutes perceive as unique about their synchrotrons:

- location
- being the first or only one
- being new/having a state of the art lightsource
- having collaboration partners onsite
- European radiation standard gives outstanding position in metrology
- quality of service
- quality of detectors
- selection of techniques
- dedicated service team

Synchrotrons believe the following typical factors might block industrial usage:

1. Confidentiality concerns, especially if the synchrotron is located on an open campus.
2. If (specific) service and speed are lacking or are perceived by industry to be lacking, that might prevent industrial customers from using a synchrotron.
3. Industry might worry that research is not focused; there might be a "culture-clash" between industry and scientists.
4. High costs.
5. Overbooking (stated once as a possible blocking factor).

We compared this with one statement from an industrial customer and found that the four points from above were more or less reflected in the industrial view, but there were also four additional points that were brought up.
Below are the answers received to the following question:
"Do you know companies in your field that do not use synchrotron radiation? If yes, do you know why?"

1. "Confidentiality, IPR, secrecy agreements"
2. "Lack of experienced beamline staff"
3. "'Cultural differences' between industry and academic use:
    i. Larger amounts of samples
    ii. Faster results are demanded + fast access needed
    iii. Robust methods + on-line analyses are needed"

[5] Numbers in parentheses throughout the document give the exact number from the average according to the evaluation scheme that can be found in the Appendix.

4. “For many companies the expenses are too high: travel+hotel+beamtime+experienced employees.”
5. “Many experienced researches are needed: Complex experiments and data analysis; difficult to get unique results”
6. “Large distance to synchrotron : equipment + travel”
7. “Industry is product and process oriented and not focused on one technique or fundamental understanding as many synchrotrons (and academic users) are.”
8. “The reviewing process at synchrotrons mainly considers scientific excellence and not technological or commercial importance”

The following factors were perceived to be helpful by the synchrotrons:

- Additional service, not just beamtime availability
- Flexibility
- General availability of beamtime (= fast access ?)
- It helps if the government pushes for industrial usage
- Geography
- Being a 3rd generation source

4.4.4.2 Organisation and Price System of Beamtime

4.4.4.2.1 Application process

Across all synchrotrons the application process for non-industrial users takes place within a similar peer review system.
In this general application process the shortest possible time span between submission of a proposal and receiving actual beamtime ranges across the synchrotrons from one to six months. (On average the shortest time span lies around four months). The longest time span between applying for and receiving beamtime lies between six months to 1.5 years. The longest average time span in the peer review system is 10.7 months across the institutes. Overall, the average time span users must wait for beamtime is seven months.
A possibility of more rapid access for industry (one of the factors perceived to be helpful by synchrotrons and industrial customers alike) ranges from less than one week to one month and is usually associated with a higher price for the faster access.
Only one institute stated that the waiting time for industry to get access can be longer, namely between two to three months and sometimes even eight months, depending on the experiment, the beamline, and the booking/overbooking status of the beamline.
The NSLS had no rapid access for industry in the past, but is undergoing a trial phase for it and has planned to establish rapid access for industrial users in the near future.

Industrial customers usually apply for beamtime via an Internet gateway and/or e-mail.
Almost no one uses regular mail; at some institutes, an electronic application is the only possibility. Half of the customers apply over the phone; if a personal contact exists, that person is called.

4.4.4.2.2 Price System

Prices are usually calculated in shifts of eight hours. At one institute, it is possible to book beamtime on an hourly basis.

All synchrotrons make a distinction between published and proprietary research.
Published research is usually free, except at one institute that charges the real costs for research published within one year. Only one institute makes a slightly different distinction between types of research: they distinguish on the one hand between fundamental and applied research and between published and proprietary. Fundamental research is always free, whether academic or industrial (which would be in concordance with what all others term “published” research). “Applied research” defines research for which the allocation of beamtime bypasses the peer review system and is granted at director’s discretion.

The price for one hour of beamtime for proprietary research ranges from €100 to €930. The average sales price is €313 .
Additional information on the calculation of the average: three institutes gave a lowest and highest price; for those we averaged a price out of the lowest and the highest without knowledge of how many hours were in fact sold for the more “expensive” price, because that information was not given. The others stated an average price themselves.
Figure 29 below shows the average sales price of 1 hour beamtime at individual synchrotrons.
One can discern 4 price groups: three institutes offer one hour for less than € 150, three charge between € 250 and € 450 per hour, three charge more than € 550 per hour, and one charges more than € 750.

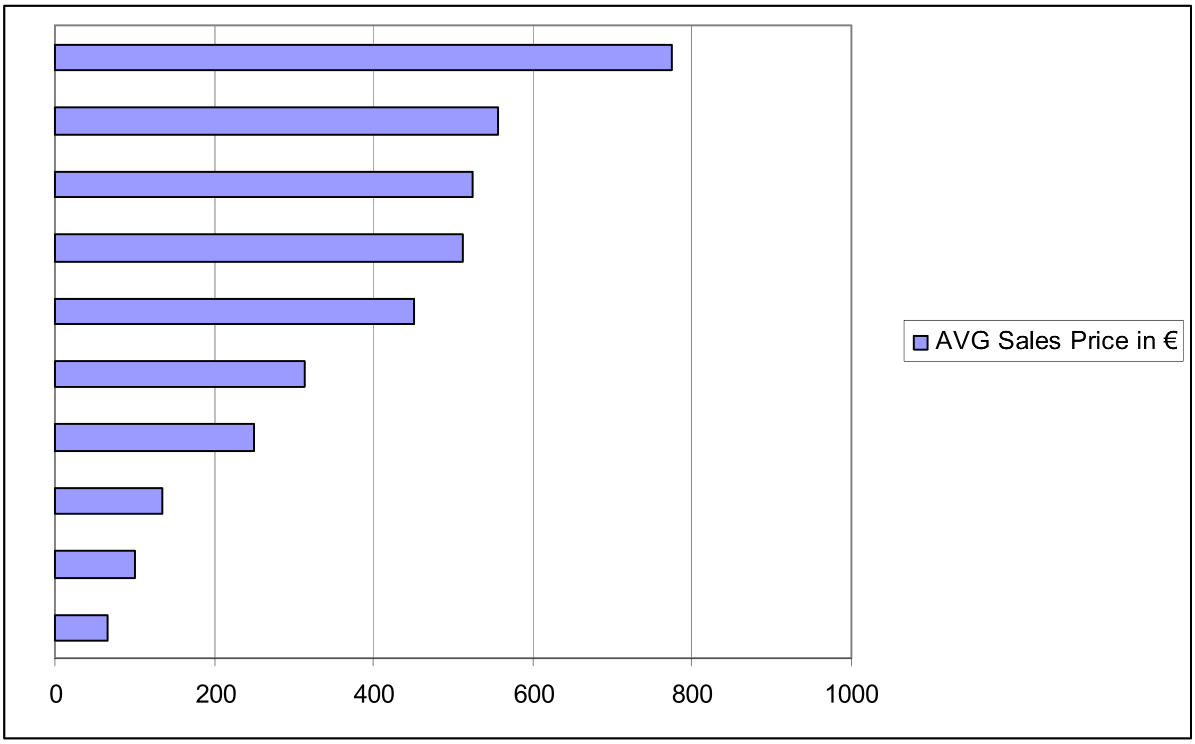

Figure 29 Average Sales Price for 1h beamtime

Five named the price for one hour of service - it ranges from €100 to €175. Three did not want to name their price for service. At two institutes the service is included in the beamtime price, although these two institutes are surprisingly positioned in the lowest price segment concerning their average prices. Two institutes charge different service prices depending on the qualifications of the person providing the service.

In general, the price calculation is done according to the model “real costs plus margin”. However, the method used to define the real costs varies amongst the institutes, primarily regarding to what extent the building costs for the synchrotron are taken into consideration when calculating the price. One example model: standard calculation basis for proprietary, non-published research is 2.5 times real costs; higher prices depend on special services, rapid access, etc. Four synchrotrons have not calculated their real costs down to the last detail for the price calculation. Five have calculated these real costs.

Three charge additional or higher fees for Mail-In Service in the field of Protein Crystallography. This is done as follows:

Two institutes charge €50-150 per hour on top of the normal beamtime price for protein crystallography measurements. One institute calculates the prices per crystal: €310 per crystal plus €4 for each image, so the customer can decide how many images they want and thus only have to pay for that number.

4.4.4.2.3 Annual turnover from Industrial use

Among the European synchrotrons looked at in this study, the average annual turnover from industrial use ranges from € 50,000 to € 2.5 million, which results in a mean average of €659.286.

Two institutes could not give information on their annual turnover and budget percentages and development because they have only just started operation. For one institute, where the lightsource is embedded into a bigger structure, the budget for the lightsource was not available and hence we could not compare the percentage of the budget with the others.

We asked the remaining six what percentage income earned from industrial synchrotron usage constitutes of the total budget and what percentage it represents in comparison to the total additional income from all industrial activities (not applicable in three cases).

“Table 1 Annual Turnover” shows percentages of industrial income ordered by increasing size of the total budget.

Budget	10 Mio	20 Mio	20 Mio	24,7 Mio.	30 Mio	80 Mio
Annual turnover in € from industry	50,000	188,000	120,000	735,000	92,000	2.5 Mio
% of additional income	--	35	--	15	9.2	--
% of total budget	0.5	0.9	0.6	3	0.3	3.1

Table 1 Annual Turnover of six synchrotrons

Figure 30 Average Annual Turnover from Industrial Usage shows the absolute number of the annual turnover for seven[6] synchrotrons in a pie chart. It can be clearly seen that one institute turns in more than half of all the others taken together.

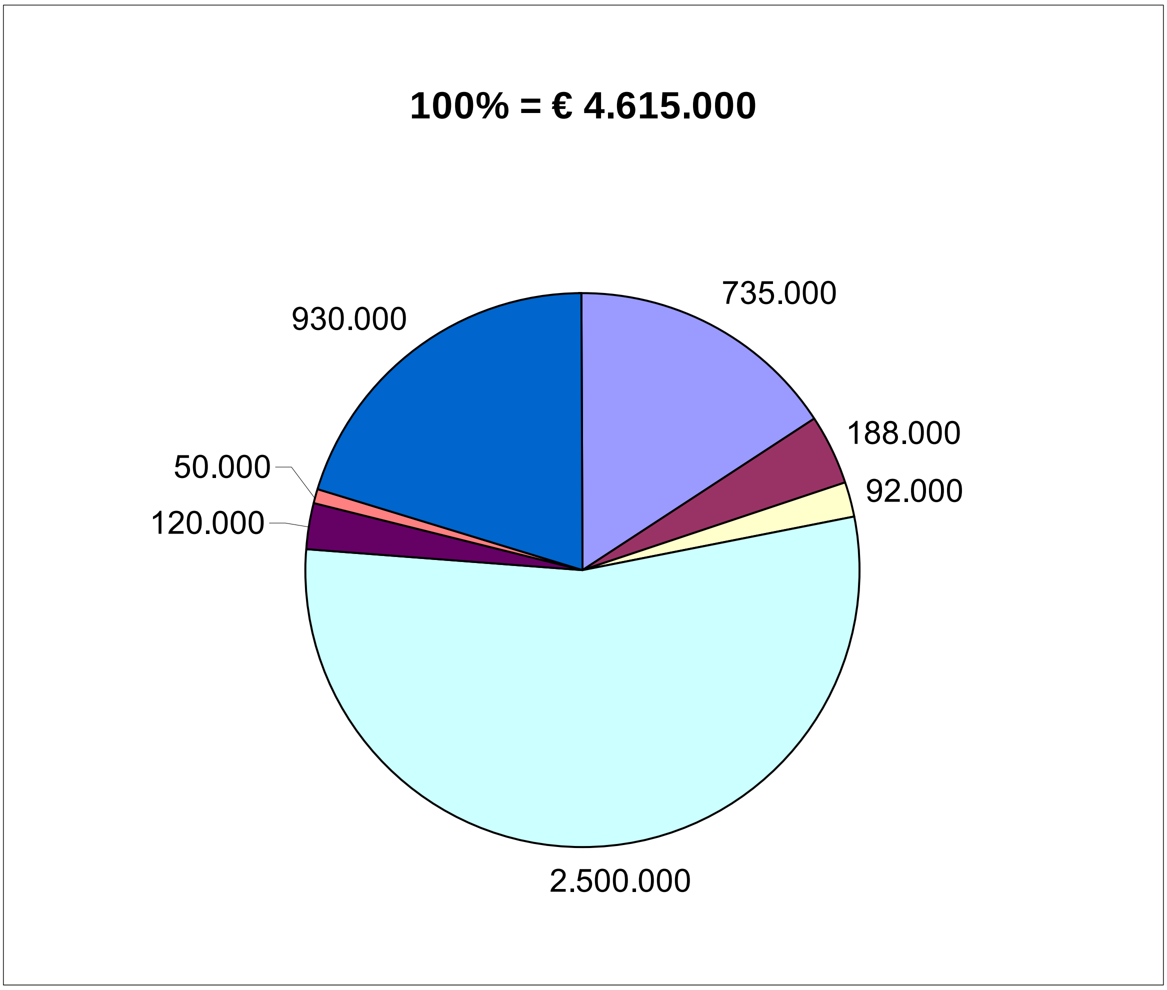

Figure 30 Average Annual Turnover from Industrial Usage for 7 synchrotrons in € (2005 - 2007)

[6] For two synchrotrons, the numbers were not yet available, as they had only recently started operation.

4.4.4.3 Industrial Usage

4.4.4.3.1 Beamtime usage

Across the synchrotrons, total available beamtime ranges from 64,000 up to 125,000 hours per year. The mean average across the institutes is 104,540 hours per year. Of these, a range from 219 to 3700 hours per year is used by industry, which equals a percentage of 0.2% to 12%.

Where applicable[7], this industrial usage has been stagnant over the last three years or undergone a slight increase. Only one institute had a decrease of 25% in the considered time frame of the three years between 2005 and 2007[8], but they, too, expect a positive trend again from smaller spin-off companies from the fields of Life Sciences and Chemistry in the near future.
All but two institutes expect an increase in the future, but hardly anybody expects an increase above 10% of the total usage. All agree that, seen globally, the industrial usage of synchrotrons will experience an increase.

Figure 31 shows the Percentage of Beamtime used by Industry. It can be seen that five lie below the 2% mark; followed by one at 3.5% and one at 5.6%. The real upward exception is the synchrotron that reports 10-12% of industrial usage.

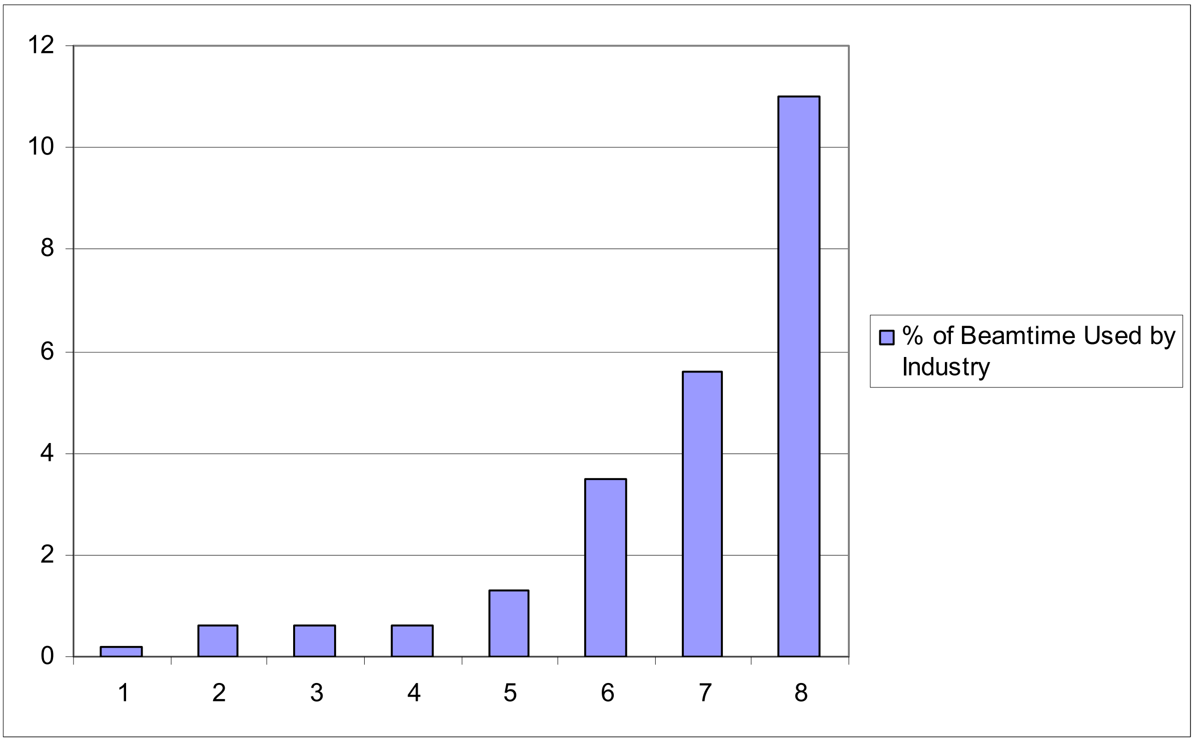

Figure 31 Percentage of Industrial Beamtime

[7] Not applicable for two synchrotrons that only recently began operations.
[8] The reason for this was that they had not been able to implement remote access for Protein Crystallography Users.

4.4.4.3.2 Number of Users and User Visits

Across the visited synchrotrons, the number of annual beamtime users lies between 700 and 6000, the number of industrial users ranges from 4 to 50 users per year. Figure 32 below shows the distribution among the synchrotrons; only one institute was omitted for which it was too early to provide data. The average number of industrial users is 27.

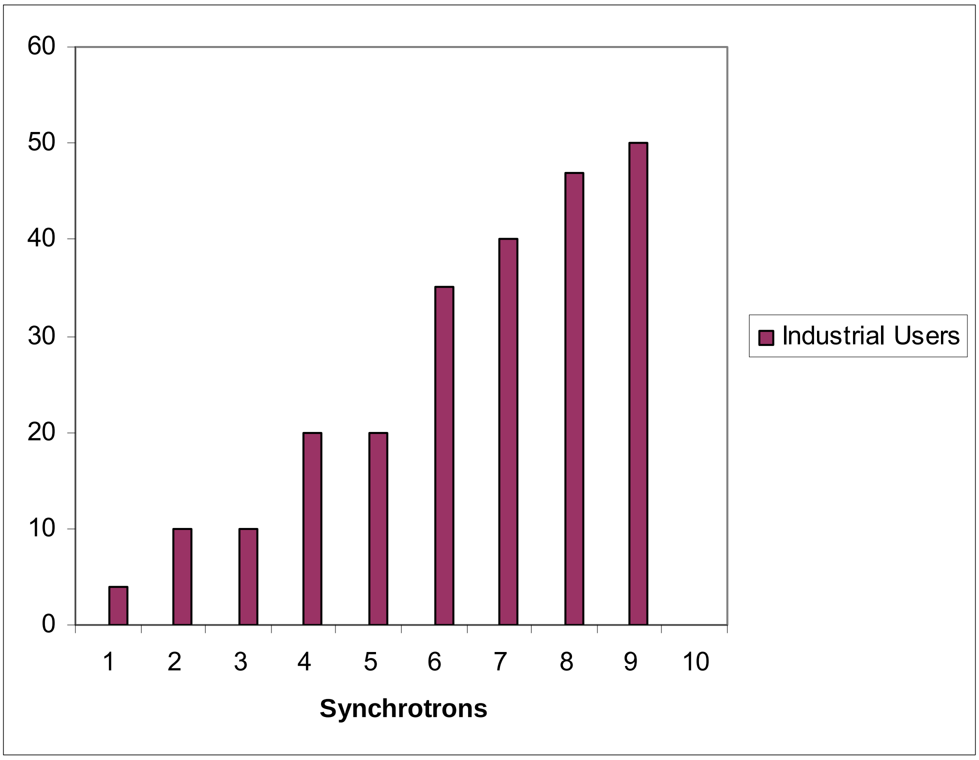

Figure 32 Number of Industrial Users at individual Synchrotrons

These customers tend to visit more than once a year, so that the number of industrial visits is more significant and usually several times larger than the number of industrial users. For example, at the institute with the highest industrial usage in the study, the customers originate from only ca. 20 companies – a number lower than the average number found in this study (27 industrial customers per institute). The company stated that there are often different customers from the same company.

At the NSLS, there are 2200 user visits per year; 154 of these are industrial users, which equals 7%. This is quite high, and only topped by the European institute mentioned above that reports 11% of its user visits as coming from industry. For the rest, the number of industrial user visits usually lies around the 3% mark[9].

[9] Except for one institute where it was too early to tell.

Figure 33 shows a count of fields that were mentioned when we asked the synchrotrons from which fields their industrial customers come. It does not tell how many customers come from which field.
At seven of the ten institutes questioned, most industrial users come from Life Sciences; these institutes also consider it the field with the most potential for the future. Though four out of all questioned institutes judge Chemistry and Energy as almost equally important as Life Sciences, only one institute has the majority of its customers from the field Chemistry and Energy.
Another institute sees the greatest potential future relevance in Electronics. Figure 33 below shows how many synchrotrons have customers from each field.

The column Toolbuilding also includes Machine Construction (including special equipment like detectors, etc.)
The field Other includes, for example, R&D Consulting.

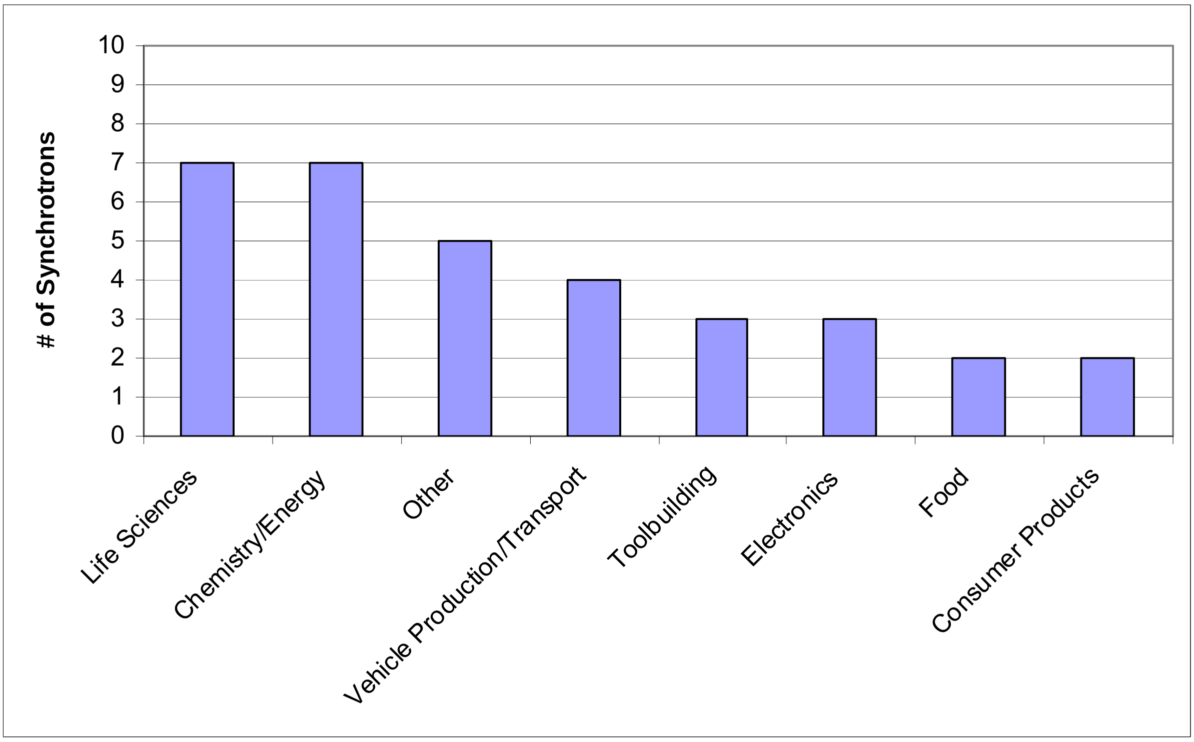

Figure 33 Customer Fields

4.4.4.3.3 Which methods are preferred by which fields?

To list the wide variety of beamline techniques used across the institutes goes beyond the intent of this study. Usually every institute offers an extensive listing of beamline techniques on their respective webpage. Here, we will only discuss the most common methods.

At six institutes, X-Ray diffraction (XRD) was mentioned as the most preferred method by industrial users, at two X-Ray Absorption Spectroscopy (XAFS), at one additionally X-Ray fluorescence spectroscopy (XRFS), and at yet another institute, the importance of XRD is closely followed by metrology and Lithography/Micromechanics. Figure 34 shows how often synchrotrons mentioned one particular method among the most important.

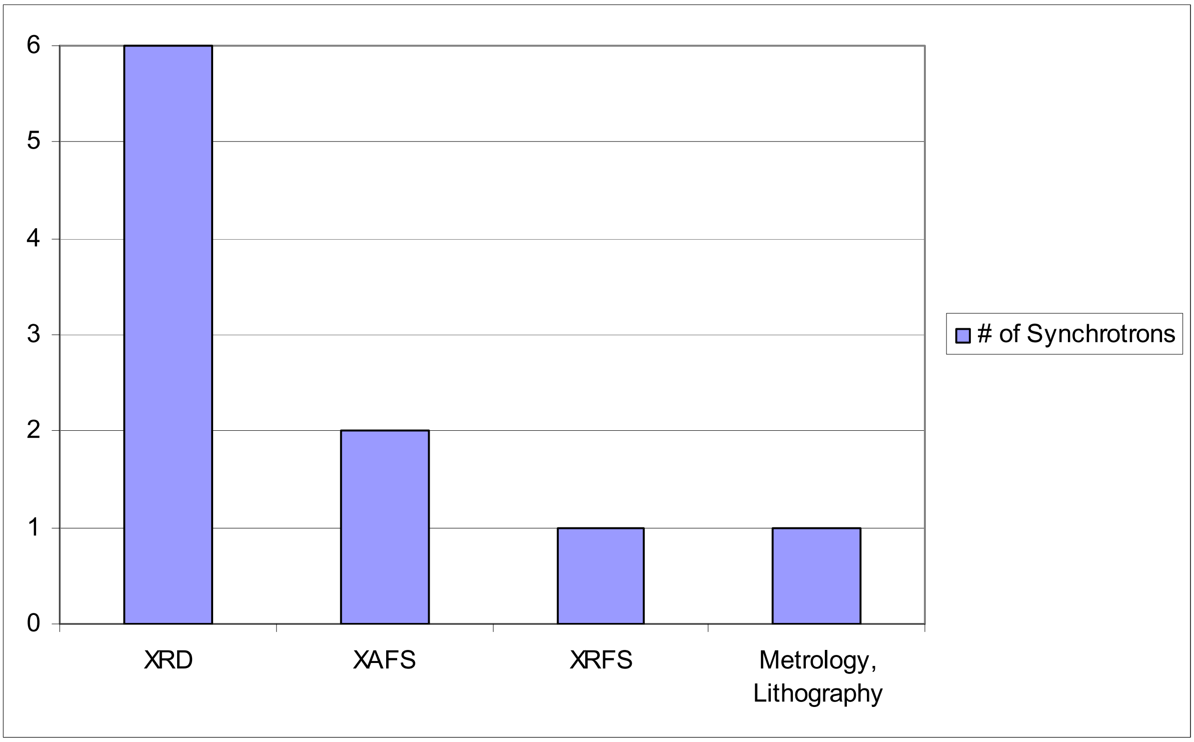

Figure 34 Preferred Methods

Although there are indicators that specific methods might be of special interest to specific custom fields, it is not possible to generally assign specific methods exclusively to one field; only for X-Ray Diffraction is there a clear tendency of usage by customers from the Life Sciences field.

4.4.4.4 Industry Service

Figure 35 below shows how many synchrotrons offer which kind of service. All Synchrotrons offer help in setting up the experiment and some kind of help by a beamline scientist. The different services are described further in the text following Figure 35. Evaluation of the different services only reflects the opinions of the European synchrotrons; an overview of those evaluations follows in Figure 36 (see section 4.4.4.4.2).

4.4.4.4.1 Types of Service

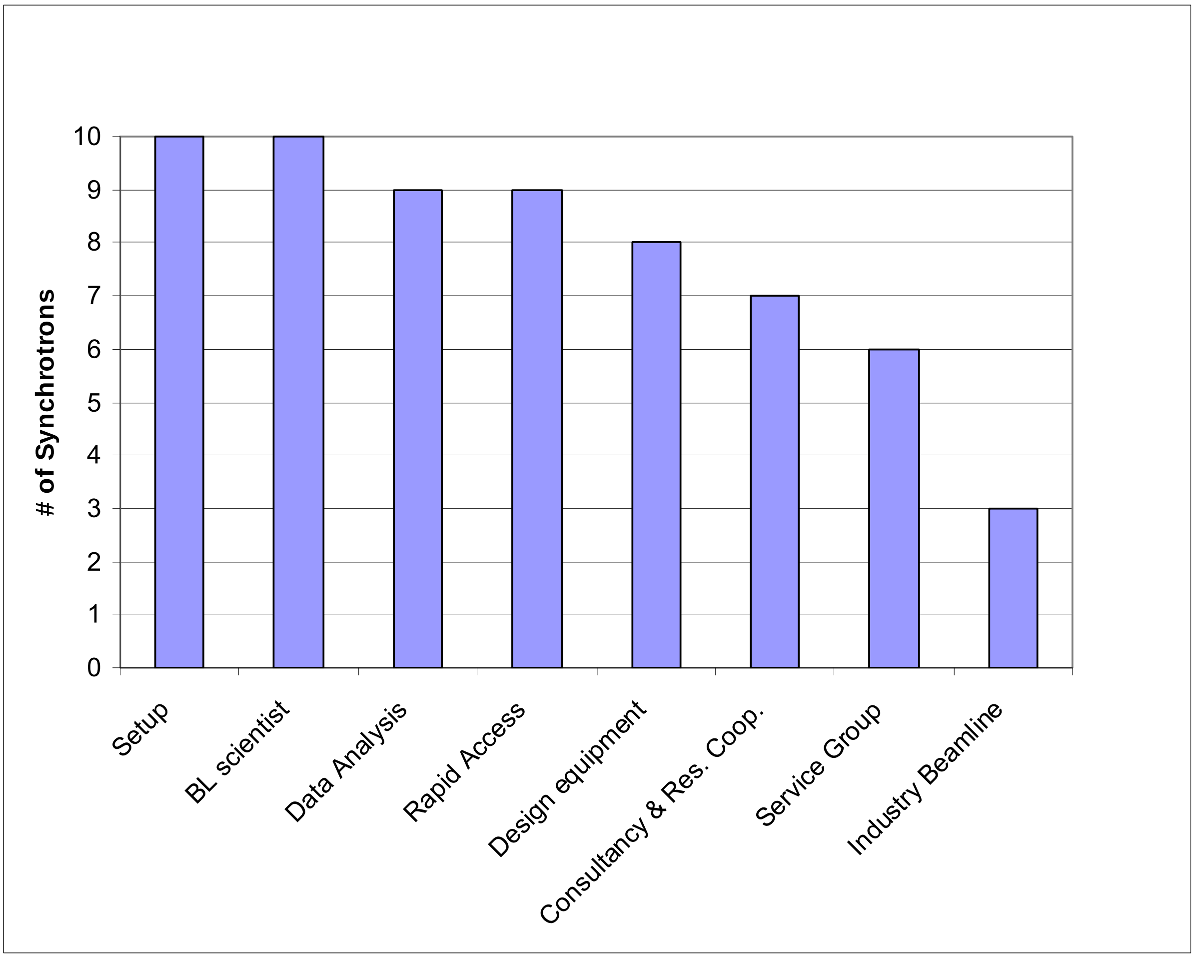

Figure 35 Industry Service

- **Experimental set-up**

All synchrotrons offer experimental set-up.
Furthermore, nearly all make a scientist or technician from the institution available to carry out measurements. The one that currently does not offer this service plans to make it available for customers that need it. On average, offering to set up experiments for industrial users is evaluated as very important (5).

- **General assistance by a beamline scientist**

All synchrotrons offer general assistance by a beamline scientist**.** We made a further distinction that is not included in Figure 35 and Figure 36: at half the synchrotrons, either this beamline scientist can be permanently present or the help of an institution's scientist/technician is permanently available. Two offer this on an as-needed basis. One does not offer it yet, but plans to change this in the future. 24-hour assistance is rated as important (4).

Being able to offer some kind of assistance is generally considered to be one of the most important service features (5.6). “*We do not leave them alone with their problems.*”

- **Analysis of measurement results**

All European synchrotrons offer an analysis of the measurement results and reports by an institution’s scientist and consider this as very important (4.8). At the NSLS, this service is presently not offered. Eight institutes also write reports and carry out final presentations of the analysis for the companies. Two do not do this. The ones who do the presentations evaluate them on average as very important, whereas the two who do not offer it regard a presentation of the data analysis as not very important (2-3).

- **Rapid access to beamtime**

All European synchrotrons offer rapid access to beamtime for industrial users. They can bypass the peer review process and thus receive beamtime five to ten times faster.
This results in access being approved from within a week to one month, but is usually associated with a higher price for the faster access.
Only one institute stated that the waiting time for industry to get access can be longer, namely between two to three months and sometimes even eight months, depending on the experiment, the beamline, and the booking/overbooking status of the beamline. The NSLS has not offered it in the past, but it is undergoing a trial phase for rapid access and has plans to establish rapid access for industrial users in the near future.

Rapid access is generally considered to be one of the most important service offerings (5.7 and 6).

- **Design of equipment**

Seven of the interviewed institutes design and produce special equipment required for measurement and consider it important (4). Two do not offer this, but one of them wants to implement this service in the future and both regard this as moderately important (3).

- **Consultancy for industry and research cooperation projects**

Eight institutes act as consultants for industry regarding research programmes with synchrotron radiation or plan to do it and evaluate this as a an important service (3.7). These seven institutes also offer research cooperation for industrial problems, which they judge as very important (4.9)[10].
Two do not offer this kind of consultation or research cooperation for industrial problems and evaluate it as not very important (3). At the NSLS, this kind of consultation is only realized via the Participating Research Teams, which will be explained in the next section.

- **Special Service Group**

Six institutes have special Industrial Service Groups, whereas three do not. The group size ranges from one to five full time equivalents (FTEs), the average group size is 2.4 FTEs. The members of these groups are either (former) scientists or engineers, who get support from administration or marketing. Their job includes among other things liaising between scientists and industry.

[10] To make Figure 36 more readable we have combined the two evaluations to one average value of 4.3.

For three institutes, the Industrial Service Group has a link to a technology transfer group of the institute that the research infrastructure belongs to or to some other governmental administrative superstructure.

There is one case where a company was founded to deal with the large and long-term industrial customers of the synchrotron. In this case, only the "small/one-time" industrial users are handled by the institute's technology transfer group. Furthermore, there is no separate service group, since the core tasks of the service group are covered by the company founded explicitly for that purpose. At the NSLS, there is no special service group for industrial users; they are covered by the General User Administration.

- **Industry Beamlines**

Three institutes operate or plan to operate industry beamlines, though at one institute a beamline has been financed by industry together with a research institute, and the institute is still allowed to use part of the beamtime. Another institute has a microfabrication beamline, and had commissioned one beamline for industry. All evaluate this as (very) important (4-5).

On the other hand, another institute reported from experience that it can be problematic to build a special industry beamline, because the needs of industrial users might change more quickly than the beamline can be financed and finished.

Six institutes do not have special industry-owned beamlines (though at two of these institutes, there is a beamline used exclusively by industry). The institutes judged this as not very important (2.2).

The NSLS uses the model of **Participating Research Teams (PRTs)**, where research institutions together with companies combine their resources to build and operate a beamline. More about PRTs can be found in section 4.4.4.6, "Summary of Industrial Usage at the NSLS".

4.4.4.4.2 Evaluation of Services

Figure 36 below shows how the services are evaluated on average by the European synchrotrons. We make a distinction between the evaluation by synchrotrons who offer the service and those who do not, wherever applicable. We do not have any evaluation of having a Special Service Group, therefore this service is missing in the figure below.

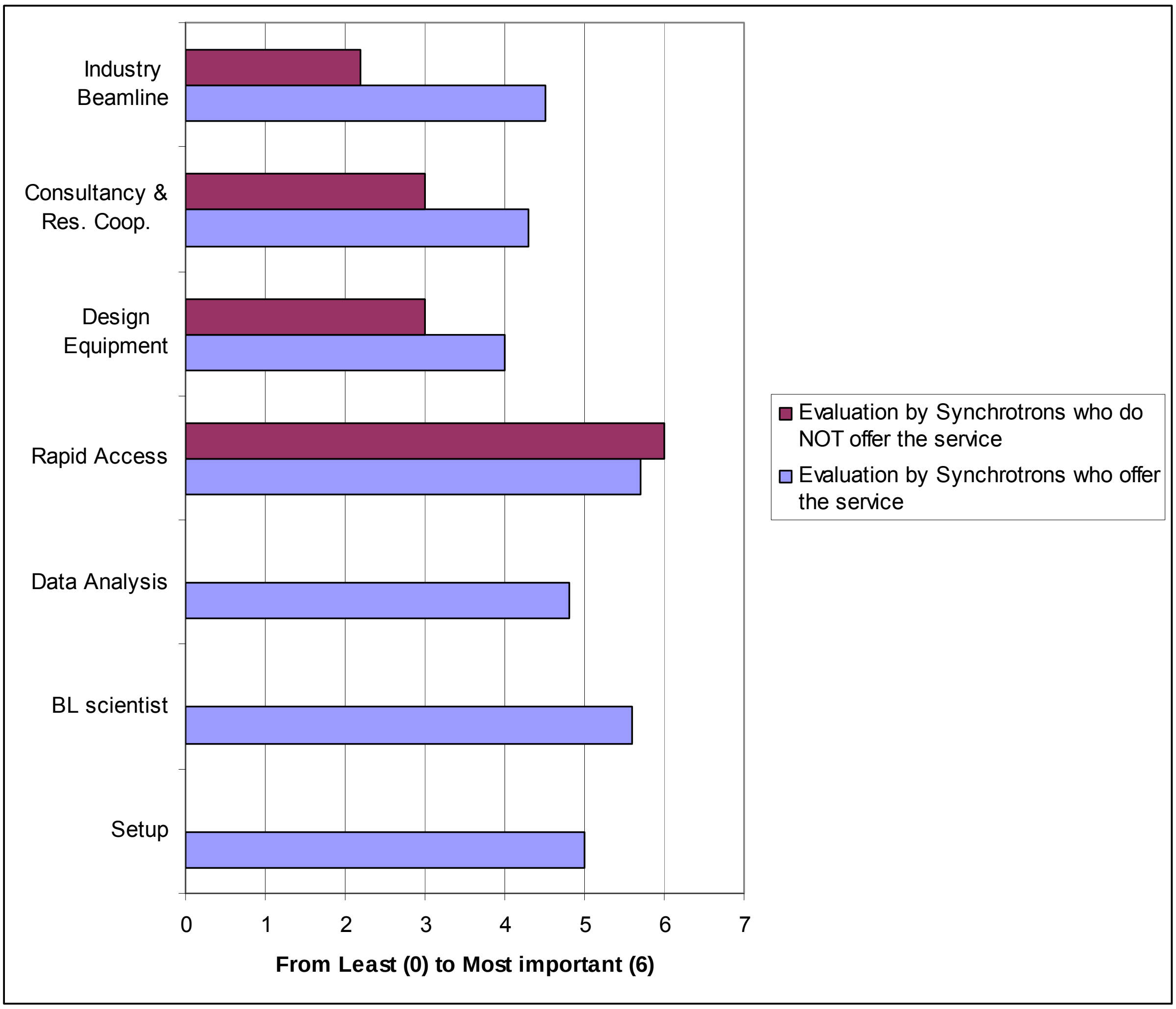

Figure 36 Evaluation of Industry Services by European Synchrotrons

4.4.4.5 Marketing

Across the range of interviewed synchrotrons, we compared a number of marketing instruments.

When asked if anything was missing on our list of marketing instruments, the majority of synchrotrons answered that they consider networking as the main marketing instrument. Networking for them means going to (scientific) conferences, meeting people, and developing ideas in conversations where experts from different fields come together.

One interviewee said “It really is a People-to-People business.”

We do not list it as a separate instrument, since it can be seen more as the underlying, but all-important theme permeating all marketing efforts.

4.4.4.5.1 *Main Marketing Instruments*

Figure 37 shows the usage of marketing instruments, followed by a detailed description of each instrument. An overview of the evaluation of marketing instruments is shown in Figure 38 at the end of this chapter.

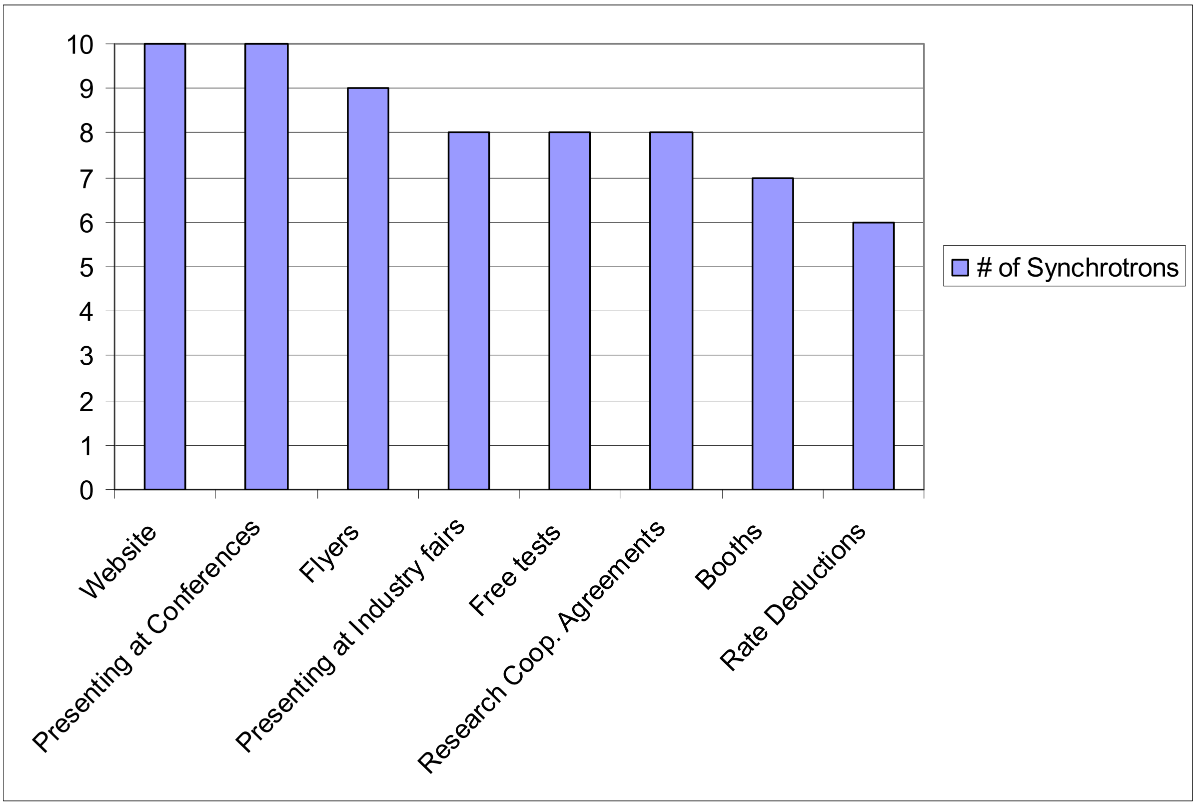

Figure 37 Marketing Instruments

- **Website and general visibility**

All synchrotrons use a website for marketing beamtime to industrial users and consider this a very important means for visibility and marketing (5.4). It offers a platform familiar to all to share knowledge. One institute also offers a consultation database.

- **Presentations directed to industry at workshops / conferences**

All synchrotrons send employees to scientific workshops and conferences and consider these events to be very important (4.9). At these scientific conferences, people from the synchrotrons present the results of their research and thus transfer the knowledge of the latest scientific developments. Since it is well-known that people from industry also attend these conferences, presentations can be geared towards informing industry. One interviewee said "Sometimes we hint that you can buy these things [that are presented in the talk]."

These conferences are considered an important opportunity for contact between scientists and companies.

- **Flyers & Brochures**

Nine synchrotrons print flyers and brochures and distribute them for marketing purposes and rate this as important (3.9). One does not use such printed material.

- **Presentations and visits at industry fairs**

Seven synchrotrons use presentations and visits at industry fairs, but two of those only do so rarely. This was evaluated as quite important (4.5). Two synchrotrons do not visit industry fairs and do not regard them as important. It appears that when a synchrotron is embedded within a larger institute, institute-wide technology transfer activities may lead to more action at industry fairs.

- **Free tests and method evaluation**

Eight institutes offer free tests and method evaluation and consider this on average to be important (4.5). One institute has offered tests only during the commissioning process of beamlines and considers it not so important (3).

In general, free tests are offered for bigger/long-term companies when a beamline with a new method is commissioned or to draw in new customers. It was noted by one institute that they are not very convinced of the usefulness of free tests, because of the possibility of misuse.

- **Research cooperation agreements**

Seven institutes enter into research cooperation agreements and view them as important (3.9).
Two institutes do not offer research cooperation agreements and consider it to be least important (1).

At the NSLS, the Participating Research Team of the National Institute of Standards and Technology (NIST) works collaboratively with industrial partners in diverse materials science applications via Cooperative Research and Development Agreements (CRADAs). This is evaluated as important (4). For a further description of PRTs and CRADAs, see Section 4.6.2.

- **Booths at fairs and conferences**

Seven institutes set up booths at conferences and consider this on average to be quite important (4.4). It was noted that although booths at conferences serve the visibility and general public relations goals of an institute quite well, the direct results in terms of contracts, etc. are rather low. Three institutes do not have booths and consider them to be least important (1).

- **Rate deductions**

There are varying policies regarding rate deductions. Six institutes offer rate deductions and consider it on average as important (4.4). One grants rate deductions depending on whether the measurement project might be interesting to the research interests of the institute. Two do not offer rate deductions and consider them to be least important (1). For one institute, it is forbidden to give rate deductions.

The NSLS does not give rate deductions.

4.4.4.5.2 Further Marketing Instruments

Further marketing methods mentioned by individual institutes include

- industry days,
- presentations or seminars for special corporate customers,
- salespeople visiting companies,
- market surveys,
- cold calls.

Two institutes arrange general industry days, sometimes relating to a specific topic.
One of the institutes remarked that it was important not to select an overly specialized topic for an event like this; the topic has to be focused enough not to sound too general, but also interesting enough for a large number of users, as an event like this is in competition with a huge variety of similar events from all kinds of organisations. They considered it more effective to present together with others within a larger framework.

Two institutes provide or plan to provide presentations/seminars for corporations at their own institutes and view this as much more effective than general industry days (6).
Two synchrotrons had salespeople visiting companies or were planning to do so. This was evaluated as important (4).
One institute plans a catalogue to draw in small to medium-sized local companies that do research or applications. The catalogue is intended to comprise services and products and provide examples of research from different fields (Chemistry, Medicine, Energy and Environment, Electronics, Information Technology). They want to distribute it to selected users to understand the needs of customers; it is crucial to recognize analogies between fields to be able to offer the right solution. Cold calls are only very rarely done and only if it is obvious that a company might find a use for an offered technique.

4.4.4.5.3 *Evaluation of Main Marketing Instruments*

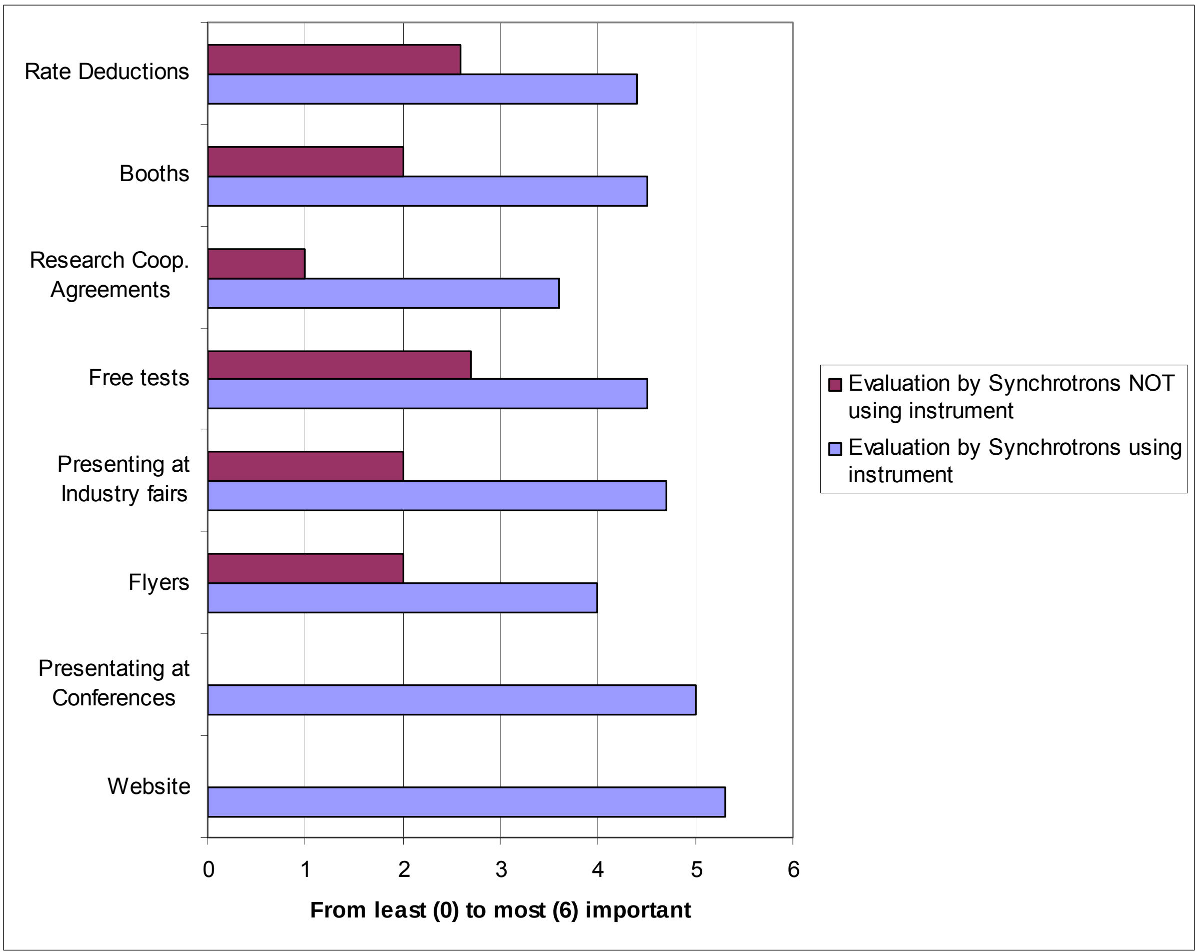

Figure 38 Evaluation of Marketing Instrument

4.4.4.6 Summary of Industrial Usage at the NSLS

We started out looking closely at the NSLS and took their model as a point of comparison throughout the study. When calculating averages, we took the NSLS data into account as just one out of ten considered synchrotrons, mentioning noteworthy (i.e. different from European) features when they occurred.

A much higher percentage of their industrial users comes from the area of Research and Development Consultation (10%). Across the European synchrotrons, companies from Research and Development Consultation were few and far between.
The percentage of industrial users equals 7%, which is quite high. There is only one other European institute that reports even more, namely 11% of its user visits as coming from industry. Equally, the percentage of industrial usage of total available beamtime is relatively high. It constitutes around 5.6% and is again only topped by one of the European institutes.

It is quite interesting to note in this context that the NSLS does not yet offer rapid access[11] for industry and has a beamline scientist only at the facility beamlines. It seems that the longstanding models of Participating Research Teams and Contributing Users and arrangements of companies with these or the universities seem to work quite well.
It is interesting to note that there seems to be more transparency for the cases of companies conducting measurements and research via universities. Across the studied European synchrotrons, it was uniformly stated that synchrotron staff does not know how many companies carry out measurements at beamlines via a university without the synchrotron knowing about the fact that company research is being carried out. The NSLS stated that as far as they were aware, they did not have these cases, as they kept close watch on the number and quality of publications. If people were not publishing, then they might not get a renewal on their beamline contract.

A summary of the structure and overall organisation of the NSLS is given below. At the NSLS, an internal report has been compiled by NSLS staff about industrial usage, wherein data relating to industrial users have been compared for FY 2006. Data used for NSLS are taken mainly from this report.

4.4.4.6.1 General structure of NSLS and BNL

NSLS is part of the Brookhaven National Laboratory (BNL), funded by the U. S. Department of Energy (DOE). The Laboratory operates large-scale facilities for studies in physics, chemistry, biology, medicine, applied science, and advanced technology.
Staff BNL: 2600
Visiting researchers BNL: >5000/year
Staff NSLS: 214
Visiting Users: 2200/year

BNL is operated for the DOE by Brookhaven Science Associates (BSA), a non-profit, limited-liability company founded by Battelle (www.battelle.org) and Stony Brook University.

4.4.4.6.2 Access of Beam time

(Industrial) Access can be gained via the following ways:
(Note: not every one of the methods below is a formalized process)

- **Submission of a Two-Year-Proposal (General User)**

The proposal is rated by a peer-review panel of experts in the field.
3 Cycles of beamtime/year.
Ca. 100 new proposals each cycle.
Procedure requires the user to submit the proposal 3 months prior to the cycle in which they would like to perform.
(Note: It is difficult for companies to compete with a University User proposal, because generally, basic research is bound to get better reviewing points than applied research).
The rated proposal remains active for two years; users can continue to request beam time against it.

[11] But the waiting time for receiving beamtime is fairly low, namely 3-6months. (6 months is the average of the European synchrotrons from the present study).

- **Participating Research Team (PRT)**

PRTs design, construct and maintain beamlines and carry out the day to day activities of managing a Beamline at the NSLS. The PRT has complete control over the beamline and manages its scientific programme for up to 75% of the available beam time for a period of up to three years with the possibility of renewal. The remaining 25% must be made available to general users.
Note: PRTs exist for historical reasons - when NSLS was built in 1982 they were founded to finance the building of beamlines.

- **Contributing User (CU)**

Contributing Users are individuals or groups who carry out research at NSLS Facility Beamlines and also enhance beamline capabilities and/or contribute to their operation. CUs typically do no set up an entire Beamline, but will provide some equipment or support for general users. Most CUs are academic institutions.
CUs may be recognized for their investments by receiving a specified percentage of beam time (usually 25%) on one or more Facility Beamlines for a period of up to three years, with renewal possible.

- **Arrangement with PRT or CU Member**

Some companies arrange time with a PRT or CU member, some of whom run experiments and collect data for their users; for example SUNY@Stony Brook runs up to 300 hours per year of “mail-in” proprietary work for various companies at the X16C beamline.

- **Proprietary Research**

Companies wanting to carry out proprietary research are required to go through the general proposal procedure as described above, and additionally, the proprietary research project has to be approved by the NSLS Chairman.
The user pays the full cost recovery-fee and in turn has the option to take title to any inventions made during the proprietary research program and to treat as proprietary all technical data gathered during the program.

- **Collaboration with NSLS Staff or University**

E.g. the National Institute of Standards and Technology (NIST) PRT works collaboratively with industrial partners in diverse materials science applications via Cooperative Research and Development Agreements (CRADAs).

4.4.4.6.3 Beamline organisation

Total number of beamlines: 67
Run by PRTs: 49
PRT beamlines belonging to industrial users: 15
Facility beamlines (run by NSLS): 18
There is a beamtime scheduler; the facility beamlines have beamline scientists.
The NSLS charges approximately $100/hour (ca. € 63), which includes electricity, small amounts of support time, and overhead for the entire laboratory, plus one hour for setup and takedown. The rate is adjusted approximately every 6 months based on electricity costs and on the number of operating hours.

Usage by Participating Research Teams (PRTs) or Contributing Users (CUs) is regulated via an agreement between the CU or PRT and the NSLS that is generally effective for 3 years, after which the beamlines are reviewed and the agreement may be renewed. Items specified by the agreement include: allocation of beamtime and laboratory space, maintaining and operating the beamline and its end stations, completion of the proposed scientific program, staffing of the beamline, making improvements in facilities, working jointly with the NSLS to promote the use of the beamline by General Users (GUs), making beamline facilities accessible to GUs at no charge, and supporting GUs accessing the beamline facilities.

4.4.4.6.4 Industrial Usage and Service

Industrial Users: 7% of total users, (in absolute numbers: 154 out of 2200)
Industrial Usage of totally available beam time: 5.6%
Industrial users visiting the NSLS in FY 2006 represented 47 different companies from several industrial areas:
37% Pharmacy
10% Research and Development Consultation
9% Microelectronics und chemical areas
The remainder came from engineering, energy and/or automotive, aerospace, and other industrial fields.
Total number of beamlines used by industry: 24
On these, spectroscopy, diffraction and scattering are by far the most used techniques.
Service is presently only offered by PRTs and CUs.

4.4.4.6.5 Marketing instruments

Website: NSLS User Administration (which also has the task of outreach and communication) meets once a week with the onsite webmaster to talk about contents for the webpage. The web page constitutes the main marketing instrument they use at the moment, as they are only in the process of changing this.

4.4.4.7 Assessment of Industrial Usage at Synchrotrons by Industry

We will now briefly sketch a few of the opinions expressed by the companies who ultimately were able to fill out our questionnaire.
Answers to the question: “How would you describe an ideal service at a synchrotron for your purposes?”

- “Experienced beamline staff on long term contracts present at the beamline at least as much as our own researchers (24 hours per day, 7 days per week). This means a multiplication of the staff with a factor of about 4 for most synchrotrons”
- “A personalized help for the administrative aspects“
- “The setting of the beamline before the start of the experiment and the arriving of the team”
- “Possibility of sample pre-treatment and preparation in a dedicated chemical lab adjacent to the beamline”
- “A reactive assistance 24h/day, 7 days/week in case of trouble”
- “Fast access to beamtime (within a few weeks)”
- “Beamlines with quality control on important parameters”
- “User friendly software, also for on-line data analysis, present at the beamline”
- “State-of-the-art equipment at the beamline”

- “Possibility of measurements on short notice and subsequent scientific discussion of the results”

4.4.5 Main Conclusions

Across the synchrotrons we interviewed, all of them wanted to increase their industrial usage and are in the process of addressing this issue in varying ways. We now offer a summary of what we have found regarding the topics Price System, Annual Turnover, Industrial Usage, Customer Fields, Industry Service and Marketing. Recommendations are given in Chapter 4.4.6.

4.4.5.1 Price System and Annual Turnover

All synchrotrons make a distinction between published and proprietary research.
Published research is mostly free.
The price for one hour of beamtime ranges from 100€ to 930€. The average sales price is €313[12] .
Five named the price for one hour of service - it ranges from € 100 to € 175.
The NSLS charges $100/hour (ca. € 63).
Three institutes charge additional or higher fees for Mail-In Service in the field of Protein Crystallography.
The average annual turnover from industrial use ranges from € 50.000 to € 2.5 Mio.
The institutes with the two highest budgets also show the highest annual turnover from industrial usage. For the rest of the institutes, a similar correlation does not hold.
The highest turnover from industrial usage was € 2.5 million, while the lowest was € 50.000. The average annual turnover of the seven institutes which could provide these numbers was € 659.286. The lowest turnover percentage was 0.3% of the budget at an institute with a budget of € 30 million.
The sum of the total annual turnover of the seven considered synchrotrons is € 4.615.000. More than half of this sum is achieved by one institute alone.

4.4.5.2 Industrial Usage and Customer Fields

Across the synchrotrons there is often a wide difference in the amount of industrial usage. Beamtime hours given to industry ranged from 219 to 3700, this equals a percentage of from 0.2% to 12%. Since all but one of the European synchrotrons experience less than 5% industrial usage, the NSLS registers the second highest industrial usage of beamtime among the compared 10 synchrotrons with its 5.6%.

The number of users ranges from 4 to 50 per year; often those users visit more than once. The NSLS lies at the upper end of the scale of this with ca. 47 companies visiting ca. 154 times per year. All but one synchrotron had the majority of its customers come form the pharmaceutical area. Only at one synchrotron was “Chemistry and Energy” the field from which most customers came.

[12] (Additional information on the calculation of the average: two institutes gave a lowest and highest price, for those we averaged a price out of the lowest and the highest without knowledge of how many hours were in fact sold for the more “expensive” price, because that information was not given. The others stated an average price themselves).

For the future, all but two institutes expect an increase in industrial usage, but hardly anybody expects an increase above 10% of the total usage. All agree that, seen globally, the industrial usage of synchrotrons will experience an increase. Life Sciences, closely followed by Chemistry and Energy, are seen as the field with the most potential for the future. One institute sees the greatest potential in Electronics. The way this is evaluated by the institutes is, of course, influenced by how they are positioned in the market. There are some institutes that place their emphasis on measurements for pharmacy, whereas others are specialized e.g. on Microelectronics.

On average, the most popular method is X-Ray diffraction, used primarily by customers from the Life Sciences field.

4.4.5.3 Industry Service

All European Synchrotrons offer rapid access for industrial customers.

The NSLS is in the process of implementing it. It is interesting that although everyone sees rapid access as an important demand of industrial customers, the NSLS already shows quite a high volume of use by industrial customers (5.6%) without having rapid access implemented yet.

Nevertheless, this is also reflected as very important in the few assessments we had from industry, but obviously there are other factors for success.

Being able to offer service to users is generally regarded as most important, especially if one wants to draw in more (local) SMEs, which was stated as a goal in several cases. Services offered can include general assistance by a beamline scientist, experimental setup, and analysis of the measurement results. Dedicated beamlines for industry are not very widespread and the opinions on their usefulness vary. Most institutes do not have a beamline established exclusively for industry, though in some cases certain beamlines are only used by industry. There is one model where a beamline is financed by industry and a research institute. This model also exists at the NSLS in the form of the Participating Research Teams (PRTs).

One European institute reported negative experiences with a beamline designed for industry, since the industrial needs changed faster than construction of the beamline could be completed.

Two thirds of the institutes have special service groups for industry that liaise between scientists and industry. In one case, an external company was founded to better service the long-term, large customers. Half of the service groups have a link to a technology transfer group of their mother institutes.

4.4.5.4 Marketing

Obviously, at the moment there is a rather indirect approach towards promoting industrial services. This can be concluded from the fact that a lot of institutes stated that networking and going to scientific conferences was an important marketing instrument. This approach appears to reflect the view that a potential customer will be impressed by the scientific achievements of an institute and immediately convinced of the quality of the product. These potential customers then have easy points of access by being able to talk directly to the right people within the framework of the conference. This reflects the belief that institutes offer an excellent research programme which industrial users can tap into.

But a lot of institutes also have seem to have reached a point where they set out to try a more direct method of marketing synchrotron radiation in the following ways:

1. Starting with a survey of the market and identifying possible customers and their needs.
2. Trying to make their product offer more transparent.
3. Developing strategies to communicate their product offerings to a designated clientele of potential customers. Among these strategies are informative and attractive websites, product catalogues, special industry service groups, flyers and free tests.
4. Enlarging the service connected with the offer of synchrotron radiation. These services should include the permanent presence of a beamline scientist, offering experimental set-up for the uninitiated, and carrying out the analysis of the data.
5. Trying to solve the problem of communicating the possibilities of synchrotron radiation and better understanding the needs of industrial users. For this, it is important to have specialized members of a service group, or at least someone who has the time and capability to "speak the language" of both the scientist and of the customer.

Excellent scientific publications by the researchers using the synchrotron are seen as an important indirect marketing effect. General visibility and reputation are assumed to help industrial usage.
This was also found in a report carried out by a consulting company (see Appendix I. References), where it was found that industry and the research infrastructure mutually gain in standing from a relationship with each other:
"This relationship acts as a two-way 'marketing' process with both the industrialists and the (…) facility proud to be associated with each other as a sign of ('branded') strength of British scientific research."

The most important marketing instruments are using a website for visibility and marketing and going to workshops and conferences to meet and network with industry members. These conferences are considered to offer possibilities for effective contact between scientists and industry. Networking is in general regarded as the most important marketing instrument.

There is a general awareness that one could try and draw in SMEs, but only with offers of service.
In the selling of synchrotron radiation, it seems especially crucial to recognize analogies between fields in order to be able to offer the right solution. Thus it is vital that experts from different fields work together: the scientists with in-depth knowledge of the methodological possibilities and the marketing and business people to mould it into a sellable product geared towards the needs of the market. It cannot be assumed that industry knows what beamlines are and what their potential uses are. Some scientists at the institutions believe that because the synchrotrons are such superb instruments, industrial users will come on their own, but to be interesting to industry, one has to know what they want. Or to cite one of the interview

partners: “Ferrari and Mercedes might be nice cars, but maybe I just need a small car to drive to work daily”.

This conclusion is in accordance with the general perception that the marketing of the beamlines has to be a joint effort between marketing/business representatives and scientists, or by people with a combination of these skill sets that can act as a liaison between science and business.

4.4.5.5 Growing market vs. competition for customers?

All but two institutes expect an increase of industrial usage of their synchrotron in the future, but hardly anybody expects industrial usage to rise above 10% of the total user time. All agree that, seen globally, the industrial usage of synchrotrons will experience an increase. But the number of synchrotrons throughout Europe is growing as well.

Consequently, the question arises whether synchrotrons should perceive each other as rivals for attracting industrial customers. There are voices stating that the overall market for industrial use of synchrotron radiation will not grow adequately: “*Now the market is getting more competitive: more actors, but the cake is not getting bigger. It cannot be our goal [among the synchrotrons] to destroy the prices, the only winners then are industry!*”

On the other hand, others seem to be completely unconcerned by the increasing number of synchrotrons and recommend considering the following points: public and nationally financed research institutes are not allowed to enter into a price competition which might leave one of them in a disadvantaged position. Furthermore, synchrotron radiation and its wide palette of related products could provide each synchrotron with the opportunity to specialize in a slightly different profile, thereby drawing different sets of customers.

For SMEs, it might be more important to contact and reach a synchrotron in the same geographical region and to be able to buy modular products and service (buying only what they really need and receiving help in determining what they really need). For these cases, the competitive factor might not be as important. On the contrary, it might be worth considering engaging in some “networking among synchrotrons”, since synchrotrons obviously encounter many of the same issues regarding industrial usage.

A regular exchange of information on these topics or attempting to combine efforts to find solutions to common problems might be beneficial to all.

Ultimately, the aim should be the expansion of the overall market, with each synchrotron finding its own position via its unique profile.

4.4.6 Main Recommendations

R-1: Maintain a service group or at least a designated person for industrial liaison to secure a communication channel between industry and science

The institute with the largest turnover has the largest service group, whereas the one with the smallest turnover does not have any service group at all.

Science has to understand industry in order to be of use to it. A productive conjunction of both worlds needs people whose job profile includes cultivating a common language for the communication between those worlds.

R-2: Use uniform statistics for recording beamtime, type of use, users and customer fields to achieve more transparency.

During the project it became evident that parameters are counted in different ways in many institutions. Even simple key figures often had to be clarified and adjusted before they could be used in this study. For future comparability of efforts and results this has to be changed.

Moreover, across the studied European Synchrotrons it was uniformly stated that often measurements at beamlines for companies' applied problems are done via scientific users, like universities, without the synchrotron knowing about the fact that company research is carried out.

R-3: Offer fast and easy access for industrial customers.

All European Synchrotrons offer rapid access for industrial customers. This is a common best practice.

Industry stated that they need "Fast access to beamtime (within a few weeks)", because in an industrial setting, usually, time is much more at a premium than money.

R-4: Carry out market analyses to be able to respond to the individual needs of different customers.

Marketing strategies have to differentiate between local SMEs or the large (maybe further away) companies. To use an analogy of one of our interview partners: "Ferrari and Mercedes might be nice cars, but maybe I just need a small car to drive to work daily"

R-5: Build a unique own profile by offering modular, fine-tuned service geared towards customer needs.

Results of market analysis have to be mapped on each specific synchrotron's possibilities to create its individual offer to industrial customers.

In some fields a more detailed or different support is needed than in others, as industry stated that they need the "Possibility of measurements on short notice and subsequent scientific discussion of the results" and sometimes even "A reactive assistance 24h/day, 7 days/week in case of trouble".

R-6: Continue and expand networking at conferences to address potential industrial users.

The majority of synchrotrons answered that they consider networking as the main marketing instrument. Networking for them means going to (scientific) conferences, meeting people, and developing ideas in conversations where experts from different fields come together.

"It really is a People-to-People business."

R-7: Combine an indirect marketing approach with a direct approach according to own profile.

The institutes with the largest turnover (extensively) use the whole range of marketing instruments.
The institutes with the smallest turnover usually engage in less marketing activities.

R-8: Further develop networking among synchrotrons to jointly achieve complete market coverage for the industrial use of synchrotrons.

"Now the market is getting more competitive: more actors, But the cake is not getting bigger. It cannot be our goal [among the synchrotrons] to destroy the prices, the only winners then are industry!"

As it is not the aim to quarrel about some niches of the market (pieces of the cake) but to explore and use the whole market (cake), only a co-operational approach will guarantee that the full potential of this market for industrial synchrotron use can be addressed.

5 References

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2. Survey of European Research Infrastructures, First round 2004-2005, Reported Existing Research Infrastructures
3. ESFRI European Roadmap for Research Infrastructures, Report 2006, Luxembourg: Office for Official Publications of the European Communities, 2006, ISBN 92-79-02694-1, © European Communities, 2006
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5. http://ec.europa.eu/research/infrastructures/index_en.html
6. “Industrial Research at the NSLS: Current Status and Future Plans” by Kathleen Nasta, Chi-Chang Kao in Synchrotron Radiation News, July/August 2007, Vol. 20, No. 4
7. “Review of economic impacts relating to the location of large-scale science facilities in the UK – Final report”, July 2008 by SQWconsulting; URN: 0000000050-08-S/on; http://dius.ecgroup.net/files/0000000050-08-S_on.pdf

6 List of Synchrotrons in Europe from lightsources.org

The information for this list was taken from lightsources.org

Not interviewed

1 ALBA - Synchrotron Light Facility, Spain
Reason: Not yet operational
2 ANKA - Angstromquelle Karlsruhe, Germany
Reason: Could not participate
3 CESLAB – Central European Synchrotron Laboratory, Czech Republic (external link)
Reason: Not yet operational
4 CLIO - Centre Laser Infrarouge d'Orsay, France
Reason: FEL
5 DAFNE Light, Italy
Reason: Too small; just 3 beamlines
6 DELSY - Dubna ELectron SYnchrotron, Russian Federation
Reason: Russia
7 DELTA - Dortmund Electron Test Accelerator, Germany
Reason: No industrial users
8 ELSA - Electron Stretcher Accelerator, Germany
Reason: No industrial users
9 FELBE - Free-Electron Lasers at the ELBE radiation source at the FZD, Germany
Reason: FEL
10 FELIX - Free Electron Laser for Infrared eXperiments, The Netherlands
Reason: FEL
11 ISA - Institute for Storage Ring Facilities, Denmark
Reason: No industrial users
12 ISI-800 - Institute of Metal Physics, Ukraine
Reason: Ukraine
13 Kharkov Institute of Physics and Technology, Ukraine
Reason: Ukraine
14 KSRS – Kurchatov Synchrotron Radiation Source, Russian Federation
Reason: Russia
15 MLS - Metrology Light Source, Germany
Reason: User operation began in April 2008
16 PSLS - Polish Synchrotron Light Source, Poland (external link)
Reason: No evidence of industrial users on webpage
17 TNK - F.V Lukin Institute, Russian Federation
Reason: Russia

Interviewed

1 BESSY - Berliner Elektronenspeicherring-Gesellschaft für Synchrotronstrahlung , Germany
2 Diamond Light Source, UK
3 ELETTRA - Synchrotron Light Laboratory, Italy
4 ESRF - European Synchrotron Radiation Facility, France
5 HASYLAB - Hamburger Synchrotronstrahlungslabor at DESY, Germany

7 Interviewed Institutions

Scientific Domain	Research Institute	#	Research Infrastructure	Country
Astronomy, Astrophysics, Nuclear and Particle Physics	CERN	1	LHC	EU
	ENO	2	Instituto Astrofísica de Canarias	ES
	ESA	3	International Space Station (ISS)	EU
	ESA	4	Microgravity Laboratory / Life and Physical Sciences Instrumentation Laboratory	EU
	ESO	5	Telescope 1	EU
	ESO	6	Telescope 2	EU
	GANIL	7	GANIL	FR
	IEAP CTU	8	IEAP CTU	CZ
Biomedical and Life Sciences	Copenhagen Animal Research Unit	9	CARU	DK
	Decode Genetics	10	Decode Genetics	IS
	Fleming Institute	11	The mouse facility	GR
	Fleming Institute	12	Laboratory of Protein Chemistry	GR
	HZI	13	Mouse House	DE
	HZI	14	Array facility	DE
	INSTRUCT	15	Weizmann	ISR
	INSTRUCT	16	Oxford	ISR
	University of Liege	17	Cyclotron and Imaging Platform	BE
Computation and Data Treatment	CERN	18	Grid	EU
	CINECA	19	Computation Center of 50 Teraflops	IT
	CNRS/IN2P3	20	Computation Center	FR
	GBIF	21	French Nodal Point	FR
Energy	EFDA-JET	22	EFDA-JET	EU
Environmental Sciences	AWI	23	Polarstern	DE
	AWI	24	Research Station in Antarctica	DE
	European Centre for Medium-Range Weather Forecasts	25	High Performance Computing Facility	UK
	Ifremer	26	Genavir	FR
	Ifremer	27	Test Facilities	FR
	Kew Gardens	28	The Herbarium	UK
	Kew Gardens	29	Jodrell laboratory	UK
	Large Wave Channel	30	Large Wave Channel	DE
	MNHN	31	Department of Collections	FR
	NHM	32	NHM	UK

	SINTEF Petroleum Research	33	The Large Scale Flow Loop	NO
Material Sciences	BESSY	34	BESSY	DE
	DESY	35	Hasylab	DE
	DESY	36	FLASH	DE
	Elettra	37	Elettra	IT
	Elettra	38	FERMI@Elettra	IT
	ESRF	39	ESRF	FR
	ETW	40	European Transonic Windtunnel	DE
	FOM Rijnhuizen	41	FELIX Laser Facilty	NL
	FOM Rijnhuizen	42	Magnum PSI	NL
	FORTH IESL	43	UltraViolet Laser Facility	GR
	ILL	44	ILL	FR
	Max-Lab	45	Max-Lab	SE
	PSI	46	SLS	CH
	PSI	47	SINQ	CH
	Soleil	48	Soleil Synchrotron	FR
	STFC	49	CLF	UK
	STFC	50	Diamond	UK
	STFC	51	SRS-Daresbury	UK
	Technical University of Denmark	52	Danchip Cleanroom Facilty	DK
Social Sciences and Humanties	ESS	53	ESS	EU

8 Questionnaires

8.1 Pre-Questionnaire WP1 & WP2

Thank you for taking time for the ERID-Watch project. We very much appreciate your input. Please, fill in the answers (with the help of your colleagues) and send this questionnaire back to the interviewer before the interview date. Your responses will be kept confidential within the operational team of ERID-Watch. When the final report is being drafted you will be contacted in order to accept/decline data/comments appropriate for publication. At the day of the face-to-face interview the answers from this pre-questionnaire are taken into consideration and additional qualitative questions are asked.

Name of the Institute: Address: Country:
Name: Department: Position: Tel.: E-mail:

1. Your institution – short description of your institution/ centre

All questions under topic 1 refer to the institutional level.

1.1 Name and short description of your institution

1.2 When was the institution set up? What were the reasons for setting it up?

1.3 How is your institution organised? Is it integrated in an umbrella organisation[13]?

1.4 What legal structure has your centre?

1.5 Which laws applies to your institution?

[13] *An umbrella organisation is defined in this context as any association of institutions, which formally work together to coordinate activities. For example, DESY or AWI are organised within the Helmholtz Society as umbrella organisations.*

2. Your infrastructures – short description of the Research infrastructures of your institution

The main objective of ERID-Watch is to generate information about Research Infrastructures in particular, and not only Research Institutions. A Research Infrastructure (RI) is defined as a facility or joint resource that provides unique access and services to research communities in both academic and/or technological domains. For example at DESY, the infrastructure is not DESY (even not the sites Hamburg-Bahrenfeld and Zeuthen) but the infrastructure XFEL (as a future infrastructure) and FLASH.

If you have more than one infrastructure running, please select two of them, and answer the questions accordingly. If one infrastructure which you choose cannot technically work without another specific infrastructure – please primarily select these two infrastructures which are dependent upon each other. One infrastructure could also be a future installation. All questions under topic 2 refer to the Research Infrastructures.

2.1 Research Infrastructure 1

2.1.1 Name and short description of the Infrastructure

2.1.1.1 What was the historical reason for setting up the Infrastructure?

2.1.2 Scientific domain of the Infrastructure[14]
(the division was made according to the ESFRI-Roadmap division)

- ☐ Social sciences and Humanities
- ☐ Environmental Sciences
- ☐ Energy
- ☐ Biomedical & Life Sciences
- ☐ Material Sciences
- ☐ Astronomy, Astrophysics, Nuclear & Particle Physics
- ☐ Computation and Data Treatment
- ☐ Engineering

2.1.3 Type of RI

Single sited RIs are based on one physical site while distributed means that the different parts of the infrastructure (not of the institution) are distributed to different places. A virtual RI could be a network of people without a common physical infrastructure.

- ☐ Single-sited
- ☐ Virtual
- ☐ Distributed

2.1.4 What was the total sum for capital expenditure of building this Infrastructure?

[14] The scientific domain of the infrastructure is the domain to which the equipment/facilities are classified under, and not the scientific domain of the RI users (which could come from a various range of disciplines).

2.1.5 Access

2.1.5.1 What does this infrastructure offer for external users?

2.1.5.2 To whom do you offer these allowances (target groups of users)?

2.1.5.3 Usage of these allowances to industry / scientific institutions/ internal usage in percentage?

2.2 Research Infrastructure 2

2.2.1 Name and short description of the Infrastructure

2.2.1.1 What was the historical reason for setting up the Infrastructure?

2.2.2 Scientific domain of the Infrastructure[15]

(the division was made according to the ESFRI-Roadmap division)

- ☐ Social sciences and Humanities
- ☐ Environmental Sciences
- ☐ Energy
- ☐ Biomedical & Life Sciences
- ☐ Material Sciences
- ☐ Astronomy, Astrophysics, Nuclear & Particle Physics
- ☐ Computation and Data Treatment
- ☐ Engineering

2.2.3 Type of RI

Single sited RIs are based on one physical site while distributed means that the different parts of the infrastructure (not of the institution) are distributed to different places. A virtual RI could be a network of people without a common physical infrastructure.

- ☐ Single-sited
- ☐ Virtual
- ☐ Distributed

2.2.4 What was the total sum for capital expenditure of building this infrastructure?

2.2.5 Access

2.2.5.1What does this infrastructure offer for external users?

[15] The scientific domain of the infrastructure is the domain to which the equipment/facilities are classified under, and not the scientific domain of the RI users (which could come from a various range of disciplines).

2.2.5.2 To whom do you offer these allowances (target groups of users)?

2.2.5.3 Usage of these allowances to industry / scientific institutions/ internal usage in percentage?

2.3 Please give us the names of all infrastructures your institution is involved in:

- □
- □
- □

3. Human Resources

From here on, the questions refer to your institution in general. However in some questions we specifically ask for data about the infrastructures as well.

3.1 How many people (fulltime-equivalent) are working within your institution respectively your infrastructures?

	in the whole institution	RI 1	RI 2
Administrative staff[16]			
Technical staff			
Scientific staff			

3.2 What are the skills levels (vocational qualification/ scientific qualification (students/ PhD students/ postdoc/ senior fellow and professors)) of your staff (~ in percentage)?

3.3 What is the proportion of different types (~in percentage) of employment contracts (fix-term, permanent, and freelancer)?

3.4 Please define the origin of your staff (~, in percentage)

3.4.1 Regarding their nationality?

3.4.2 Regarding the country they worked in before (~)?

3.4.3 Regarding the type (Industrial/ Public) of their former employer (~)?

[16] *We would be happy if you could provide specific figures in relation to staff working at institutional/infrastructure level.*

	Industrial employer	Public employer
Administrative staff		
Technical staff		
Scientific staff		

3.5 Visiting Scientist[17]

3.5.1 How many visiting scientists do you host at your institution per year *(regarding each of the previously mentioned RIs if possible)*?

Year	in the whole institution	RI 1	RI 2
2004			
2005			
2006			

3.5.2 What is their average stay at your institution *(~ in days)?*

3.5.3 What are the home-countries of your visiting scientist? *Please mention some typical countries.*

☐
☐
☐

4. Know-how and Technology Transfer

4.1 Institutional set-up

4.1.1 How is technology or knowledge transfer organised/ situated at your institution? *Please describe it in some words.*

4.1.2 How many people (*fulltime equivalent*) are working for the technology or knowledge transfer department?

4.1.3 What is the funding source of the technology or knowledge transfer offices – *general budget/ income from commercialisation (percentage of total income)*? If there is an income from commercialisation – what percentage is this of the total income of the office?

Do you handle inventions/ patents at your institution? If yes, continue with the following questions, if not, please tell us why and continue with question 4.3.

[17] *We refer to visiting scientists as scientists who are using your Research Infrastructures but are not paid by your institution.*

4.2 Intellectual Property

4.2.1 Number of officially notified inventions[18] at the institution per year *(if possible, specify for the two previously mentioned RIs)*?

Year	in the whole institution	RI 1	RI 2
2004			
2005			
2006			

4.2.2 Number of patent applications per year? How many of them are applied for internationally?

Year	applications	International applications
2004		
2005		
2006		

4.2.3 How many patent applications did you hold in 2006 in total? How many patent families are there?

4.2.4 How many licences were given per year?

Year	Licences
2004	
2005	
2006	

4.2.5 What was the annual income from license agreements?

Year	Income in €
2004	
2005	
2006	

[18] *Inventions which the employer has notified the employer of, but a patent has not been taken.*

4.2.6 How many licences have you given in total (including 2006)?

4.3 Spin-offs

4.3.1 How many spin-offs originate from your institution?

4.3.2 Are they located in the geographical region of your institution?

4.3.3 Do the spin-offs and your institution still have contact – which relation exists?

4.3.4 How many spin-offs were still active three years after their establishment?

4.4 Research and Development

4.4.1 Do you carry out any research such as R&D contracts for external clients?

4.4.2. What was the number of R&D contracts during the last years? How many of them were R&D contracts with industry?

Year	R&D contracts	R&D contracts with industry
2004		
2005		
2006		

4.4.3 Did other kinds of collaborative R&D projects exist?

5. Budget and procurement

5.1 Budget

5.1.1 Please specify the contributors, and the details of their contribution?

Public bodies

Name	Type of body (government, public agencies, research centres, local)	Amount € / Share (% of total contribution)	Other contributions (loans, advantages, human resources)	Context (EU project, special program, partnership)	Notes

Private companies

Name	Industry sector	Type of contribution (contracts, corporate patronage, sponsorship)	Amount € / Share (% of total contribution)	Other contributions (loans, advantages, human resources)	Context (EU project, special program, partnership)	Notes

5.1.2 Could you please define the _capital and operational expenditure_ for the last financial year for following areas *(if possible, also define specifically for the two previously mentioned RIs)*

	in the whole institution		RI 1		RI 2	
	Capital	Operat.	Capital	Operat.	Capital	Operat.
Internal	X		X		X	

Facilities						
Instruments						
Services	X		X		X	
Others						
Total annual budget						

*By **Internal** we mean the proportion of RI funding that is spent on staff and other elements not available to industry. By **Facilities** we mean the buildings, general utilities and other infrastructure not directly connected to the experiment. By **Instruments** (tools) we include the instruments, experimental infrastructure and associated technical services. By **Services** we refer to initial and ongoing services not directly connected to the experiments. By **Others** we refer to any other expenditures.*

5.1.3 How have/will the capital and operational expenditure for these areas develop(d) during the *(~ in percentage)*:

5.1.3.1 Last five years

5.1.3.2 Last ten years

5.1.3.3 Coming five years

5.1.3.4 Coming ten years

5.2 Procurement

5.2.1 What is the annual amount of procurement?

5.2.2 How many tenders do you issue a year?

5.2.3 What is the share of the annual amount of procurement dedicated to **technical** purchases (instruments, tools, services related to the experiments)?

5.2.4 What is the breakdown (in percentage) of your **technical** purchasing activities:

5.2.4.1 At regional Level?

5.2.4.2 At national Level?

5.2.4.3 At European Level?

5.2.4.4 At global Level?

5.2.5 Could you list your 10-20 major technical suppliers **for both Research Infrastructure 1 and 2** by:

Company	Country	Goods supplied	Services supplied	Specific	Notes

		Type	Quantity/ Amount€	Type	Quantity/ Amount€	development for your RI	

5.2.6 What are the main purchasing activities for the next 10 years **for both Research Infrastructure 1 and 2**, related to:

5.2.6.1 Internal

5.2.6.2 Facilities

5.2.6.3 Instruments (tools)

5.2.6.4 Services

5.2.6.5 Others

It would be nice to get some further information about your institution and your Research infrastructures (as for example annual reviews, brochures …). Perhaps you can prepare them for the interview appointment. Thank you!

8.2 Interview Guideline WP1 & WP2

Name: **Address:** **Country:**	
Type of Interview : Phone / Face to Face	
Name of Interviewer:	
Date:	
Interviewed person N°1: Research Infrastructure: Department: Position: Tel.: E-mail: Origin of contact:	**Interviewed person N°2:** Research Infrastructure: Department: Position: Tel.: E-mail: Origin of contact:
Interviewed person N°3: Research Infrastructure: Department: Position: Tel.: E-mail: Origin of contact:	**Interviewed person N°4:** Research Infrastructure: Department: Position: Tel.: E-mail: Origin of contact:

➔ *Present the ERID-Watch project*
➔ *Are there any further questions about the project?*

1. Questions about the institution

1.1 Has there been a change in the total annual budget during the last ten years? If yes, why?

1.2 Has there been a change in the budget for capital expenditure during the last ten years? If yes, why?

1.3 Which bank controls your transactions? *State bank, Public bank, …* Do you have access to any special financial support *(e.g. for the establishment of a new RI)*? If yes, what support?

1.4Who designs and approves/concludes the contracts for collaboration and TT-projects (Technology Transfer) your institution is involved in?

1.5 Which are the scientific domains you work within (scientific domain of application)? Is your organisation focusing in particular on any of these scientific domains?

1.6 If there is a foreseeable change in the future regarding scientific focus at your institution, which scientific areas would then get more attention (financial resources for instance)?

2. Research Infrastructures

2.1 Research Infrastructure 1

2.1.1 How many different research infrastructures in your scientific field are found in Europe? How big part (percentage) of the overall European market would your research infrastructure represent (looking staff/financial figures)?

2.1.2 Do you offer full R&D services for the users of the RI – if yes, on what terms/rates?

2.1.3 Do you offer basic services (housing, catering) for the user of the RI?

2.1.4 Do you offer further services for the user of the RI (placing of manpower, IP protection etc.)?

2.2 Research Infrastructure 2

2.2.1 How many different research infrastructures in your scientific field are found in Europe? How big part (percentage) of the overall European market would your research infrastructure represent (looking staff/financial figures)?

2.2.2 Do you offer full R&D services for the users of the RI – if yes, on what terms/rates?

2.2.3 Do you offer basic services (housing, catering) for the user of the RI?

2.2.4 Do you offer further services for the user of the RI (placing of manpower, IP protection etc.)?

3. Human Resources

3.1 How is the recruitment of manpower organised at your institution? Who prepares and who decides about employment decisions?

3.2 **Special Programs**

3.2.1 Does your institution encourage the transfer of human resources between industry and the scientific world? Does your institution support personnel exchange with industry in association with RI operation?

3.2.2 How does your institution recruit appropriate personnel for the operation of RIs and performance of related R&D projects?

3.2.3 Does your institution offer education of non-scientific staff? What kind of training is offered?

3.2.4 Does your institution offer special programs for postgraduates (also national programs) – if yes, which ones?

3.3 What Restrictions/ Problems do you see regarding human resources (e.g. salaries, condition of work, termed contracts) at your institution?

4. Technology and Knowledge transfer

4.1 What are the focuses in the work of your technology transfer office?

4.2 Since when is TT a prioritised domain at your institution? What changed during the last years at your institution in the area of technology or knowledge transfer –why?

4.2.1 Are the people working on TT allocated separately at each infrastructure?

4.2.2 If your technology office is taking part in any networks *(regional, national, scientific)*, which significance do these have for your organisation*?*

4.2.3 What legal boundaries could be changed to support a better technology transfer from your institution to industry?

4.3 If you are handling IP: What is your culture regarding handling Intellectual Property (*payment for the inventors,…)*? Are there ambitions to change this culture?

4.4 Did your institution experience disadvantages in respect to the exploitation of results arisen from joint R&D projects due to any regulations or contractual requirements *(for example within FP programmes or, within collaboration with industry)*? If yes, which regulations were relevant?

4.5 What do you think is a best practise experience within the area of your technology transfer office?

4.6 Do you also have a worst practise experience?

5. Public-Private Partnership (PPP) & sub-contracted tasks to industry

5.1 What is the purpose of PPPs in your institution?

5.2 How important are PPPs in respect to procurement, operation, and commercialisation?

5.3 What amount (~percentage) of annual investment at your institution is placed in PPPs?

5.4 How relevant are PPPs relative to basic and additional public funding?

5.5 What are the limits and obstacles in respect to PPPs?

5.6. Are there any good/ bad examples of PPPs which your institution have been involved in?

5.7 Are there any critical issues in relation to PPPs for the future of your RI?

5.8 How important are subcontracts in respect to procurement, operation, and commercialisation?

5.9 From which scientific area/industrial sector do your industrial partners/subcontractors come from? What is the general size *(~staff)* of these organisations?

6. Budget

6.1 Is there any significant difference in financial contribution from public bodies or private companies between the **entire institution** and for **each specific research infrastructure** 1 and 2? If yes, please specify.

6.2 Is there any significant difference in how the *capital* and *operational expenditure* will/(have) develop(ed) for the coming (/last) 5 and 10 years for the **entire institution** and for **each specific research infrastructure** 1 and 2? If yes, please specify.

6.3 If you are not satisfied with the system of how public money is transferred to your RI, which improvements to it, if any, would you like to see?

6.4 Given many partners/contributors come from other countries, some RIs have developed their own internal financial reporting rules to improve the communication between partner and RI. Have you set up specific rules for communication and reporting to your partners/contributors? If so, what are they?

6.5 Could you describe where the private money (if any), which is financing your RI, specifically goes to?

- ❑ budget for permanent staff
- ❑ budget for staff employed on project basis
- ❑ purchasing of equipment
- ❑ facilities
- ❑ no direct allocation (cumulated in general budget as well as public contributions)
- ❑ others, please specify

6.6 What changes have you seen within your budget during the last decade, from:

6.6.1 Number of contributors

6.6.2 Public bodies

6.6.3 Private companies

6.7 If there have been any phases that have had a major impact on your budget during the last decade, which have these been?

- ❑ construction
- ❑ utilisation
- ❑ major upgrades
- ❑ others, please specify

7. Procurement

7.1 Are there any differences in procurement practices between the **entire institution** and for **each specific research infrastructure** 1 and 2? If yes, please specify.

7.2 Which different types of tenders/orders exist?
Please also define specific constraints, terms of payment etcetera for these

7.3 Please describe your purchasing process.

7.4 Please describe the process for a company who wants to sell to your RI.

7.5 Who of the following are (jointly if appropriate) responsible for the procurement at your RI?

- ❑ scientific committee
- ❑ procurement department
- ❑ staff at each department
- ❑ others, please specify

7.6 Which procurement laws apply to your organisation?

- ❑ national
- ❑ European
- ❑ international
- ❑ others, please specify

7.7 Which *technology show stoppers* could you define for:

7.7.1 Present developments:

7.7.2 Future developments:

Technology Show Stoppers are defined as: Technologies which are needed to achieve overall research objectives, but are not present on the market. They can be separated in the following sectors :

- Cryogenics, Vacuum and Gas:
- Electronics:
- Power management and distribution:
- Motion and control:
- Mechanical Components and Systems:
- Optics/optronics:
- Health and safety:
- Detectors:
- Analytical systems:

- Data acquisition and handling / Computers, peripherals and software:
- Radio:
- Communication systems:
- Autonomous systems, robotics and automation:
- Pyrotechnic devices:
- Biotechnology:

7.7.3 Which *technology show stoppers* are most likely to be available on the market in the coming 1-10 years?

7.7.4 Which *technology show stoppers* are most likely **<u>not</u>** to be available on the market in the coming 1-10 years?

7.8 Which other RIs are you communicating directly with related to supply issues (technology show stoppers)?

7.9 Are there any particular benefits (apart from the financial advantage) for private companies to supply products to you?

- ❑ associated R&D
- ❑ communication
- ❑ brand image
- ❑ others, please specify

7.10 What is the direct economic impact of your purchasing activities at regional level?

7.11 How has the purchasing activity developed during the last decade with regard to suppliers:

7.11.1 Amount of suppliers?

7.11.2 Difficulty in finding appropriate suppliers?

7.11.3 Geographic origin of suppliers: regional/national/European/global?

7.11.4 Others, please specify

8. Future procurement and budget

8.1 Which are the main underlying reasons for changes (if any) in the future purchasing activity level (increase/decrease of expenditure)?

- ❑ New governmental/political focus regarding RIs/science
- ❑ Change in number of R&D contracts, with regard to
  - ➢ private companies
  - ➢ EU projects
- ❑ others, please specify

8.2 Who are the decision makers for potential changes in the future purchasing activity?

- official
- lobbying
- others, please specify

8.3 If there is a future increase in budget, how will this then be funded?

- new contributors
- new scheme of financing
- others, please specify

8.4 How do you see the future of your RI, regarding:

8.4.1 Financial aspects?

8.4.2 Competitors?

8.4.3 Development of partnerships between:

8.4.3.1 RIs?

8.4.3.2 RI and industry?

8.4.3.3 Others? please specify

8.5 How do you see the future for RIs in Europe, regarding:

8.5.1 Funding, with regard to:

8.5.1.1 FP8?

8.5.1.2 National initiatives?

8.5.1.3 Improvements in virtual technologies

8.5.1.4 Others? please specify

8.5.2 Roadmaps?

8.6 Could you describe all different reasons (not only financial ones) to communicate with industry?

8.7 Are there any barriers to communicate with industry? If yes, what barriers?

Interview Guideline Work Package 1 & 2

Attachment

What is done by whom?

	R&D	Maintenance	Use
Research Infrastructure			
Research Institution			
External (user, supplier)			

++= very much done
+= done
-= not done

What type of institution is analysed?

Main Research Institute		Main Research Infrastructure	
Hosting one RI	**Hosting several RIs**	**Hosting 1 major equipment**	**Hosting several equipments**

8.3 Interview Guideline Practice Study "Synchrotron Use"

Name: **Address:** **Country:**	
Type of Interview :	
Name of Interviewer:	
Date:	
Interviewed person N°1: Research Infrastructure: Department: Position: Tel.: E-mail: Origin of contact:	**Interviewed person N°2:** Research Infrastructure: Department: Position: Tel.: E-mail: Origin of contact:
Interviewed person N°3: Research Infrastructure: Department: Position: Tel.: E-mail: Origin of contact:	**Interviewed person N°4:** Research Infrastructure: Department: Position: Tel.: E-mail: Origin of contact:

Thank you for taking time for the ERID-Watch project. We very much appreciate your input.
The questions from this questionnaire help to supply background information to the practices study but will not be published in the ERID-Watch report, unless we have your written consent, after you received and reviewed the interview results.
➔ *I will first ask you some quantitative questions then more qualitative ones*

➔ *Methods used:*
Time period: All questions relating to an average time period refer to the 3 years between 2005-2007
➔ *Evaluation scheme: see below*

Evaluation Scheme used for questions grading quality or importance (careful: inverse to German school systems)

1 = very bad or least important

2 = bad or of little importance

3 = slightly below average (importance)

4 = slightly above average (importance)

5 = good or quite important

6 = very good or most important

0) Your Institution and your Research Infrastructure (only for RIs that have not been interviewed in ERID-Watch before)

A Research Infrastructure (RI) is defined as a facility or joint resource that provides unique access and services to research communities in both academic and/or technological domains. For example at DESY, the infrastructure is not DESY, but the infrastructure XFEL (as a future infrastructure) and FLASH.

0.1 Structure of Institution

0.1.1 What legal structure does your centre have?

0.1.2. Is the focus of your institute on applied or basic research?

0.1.3. How many people (fulltime-equivalent) are working within your institution respectively your infrastructures?

	in the whole institution	RI
Administrative staff[19]		
Technical staff		
Scientific staff		
PhD Students		
Total		

[19] *We would be happy if you could provide specific figures in relation to staff working at institutional/infrastructure level.*

0.1.4. Visiting Scientists[20]

0.1.4.1. How many visiting scientists do you host at your institution per year?

Year	in the whole institution	RI
2005		
2006		
2007		

0.1.4.2. What is their average stay at your institution *(~ in days)?*

0.1.5. How many beamtime users do you have on average per year?

0.2 Name and short description of the Infrastructure

0.2.1 How many different research infrastructures in your scientific field are found in Europe? How big a part (percentage) of the overall European market would your research infrastructure represent (looking at staff/financial figures)?

0.2.2 Do you offer further services for the user of the RI – transcending the use of or research with synchrotron radiation (placing of manpower, IP protection etc.)?

0.3 Budget

The budget data of single institutes will be treated confidential, only processed data will be used for the report. If all participants agree, we can make the single institute numbers available only internally to all participants of the Synchrotron Study

0.3.1 What has your average budget been for the year 2005-2007?

0.3.2 Is it possible to tell the distribution over the following areas?

Staff:

Investment:

Ongoing material costs:

State funding:

Private funding:

[20] *We refer to visiting scientists as scientists who are using your Research Infrastructures but are not paid by your institution.*

Funding for projects:

0.3.3 Has there been a change in the total annual budget during the last ten years? If yes, why?

0.3.4. Do you have access to any special financial support *(e.g. for the establishment of a new RI)*? If yes, what support? Loans?

1. Industrial Users

a. How many industrial users do you have on average per year?

b. From which fields do these customers come?

❑
❑

Field	% of total industrial customers	Which field is judged essential in the future
Chemistry and Energy		
Vehicle production & Transport		
Toolbuilding and Machine Construction (including special Equipment like Detectors etc.)		
Life Sciences		
Food		
Other		

❑
❑
❑
❑ Please exemplify: ____

c. How many hours of beam time were used by industry on average in the last 3 years.

i. in total ____________ hours

ii. (if so) under a special industry scheme/project _____________ hours

d. Can you tell something about the development of the industrial usage in the last three years (2005-2007)?

_____________% increase?

______________% decrease?

e. Do you have an idea which trend this development is taking in the future?

2. Industry Service

a. Which service do you offer for industrial customers? How important do you consider each service (on a scale of 1-6)

Service for Industrial Users	Yes/No	Evaluation 1-6	Special condition /information
special, e.g. faster, access to beam time / rental of Beamline			
general assistance by beam line scientist			
permanent presence/assistance of institution's scientist/technician			
experimental set-up and/or measurements by institution's scientist/technician			
design and production of special equipment required for measurement			
analysis of measurement results and reports by institution's scientist			
presentation of final analysis and reports to industry			
consultants for industry regarding research programme with synchrotron use			
offering research cooperation for industrial problems			
special industry Beamline, i.e. industrial user owns (part of) Beamline			

b. Is there a special service group for industrial users?

i. If yes, what is the size of the group? How many FTE (full time equivalents) does it have?

ii. What are the basic profiles of the persons in this group (junior/senior/leading scientist, technician, administrator, businessman)

iii. Is there an organisational link to other groups (e.g. TT …)? If yes, which?

c. How many FTEs are there for industrial service at all (including all groups)?

3. Organisation Beamtime

a. How does the application process for beamtime work in general?

b. What is the shortest and longest time period [months] between application and actual measurement for normal users?

c. Is there a shortcut application possibility for industrial users?

d. How do people apply?

i. Internet?

ii. Paper Mail?

iii. Other? Which?

4. Price system for beamtime

a. What is the price estimate for 1 hour beamtime? How does it relate to real costs?

Real costs?

Average sales price? Lowest/Highest sales price?

b. What is the price for 1 hour of the work of a scientist or technician for an industrial project?

c. Do you charge additional fees (not V.A.T.) to industry?

Is there a price system for beamtime? If yes, what kind? Could you explain the system and the reasons for the system?

d. Do prices per hour differ for published research vs. company internal research?

e. What is average annual turnover from industrial use? __________ €

f. Which percentage does the income from industrial usage make up of the total additional income? *(under the assumption that there is a general budget and then additional income generated by services and other things)*

g. Which percentage does the income from industrial usage make up of the total budget? How high is the total budget?

h. Is it allowed to subsidize beamtime for industry? Or is there the obligation to sell it at least to the price it creates?

5. Methods and techniques

a. How many beamlines does your institution have to provide the following general methods – and which special methods do you operate:

Method	No. of beamlines	Special methods provided
X-Ray Absorption Spectroscopy		
X-Ray fluorescence spectoscropy		
X-Ray diffraction		
Small Angle Scattering		
Other (specify)		

b. What is the general availability of your Beamlines?
   i. How much time is a normal Beamline accessible for all users (excluding maintenance and test runs etc.)? ____________ [hours] on average per year
   ii. How much time are all Beamlines in total accessible for the users (excluding maintenance and test runs etc.)? ____________ [hours] on average per year (= No. of Beamlines x average accessibility of one Beamline)

c. Of the following general methods which are used/preferred by industrial users? (Please give percentages, alternatively the 1-6 rating may be applicable.)
   i. X-Ray Absorption Spectroscopy (XAS)
   ____________% of total industrial use [hours] on average per year

   ii. X-Ray fluorescence spectoscropy
   ____________% of total industrial use [hours] on average per year

   iii. X-Ray diffraction (XRD)
   ____________% of total industrial use [hours] on average per year

   iv. Small Angle Scattering
   ____________% of total industrial use [hours] on average per year

d. On a scale of 1 - 6 (where 6 = most used/preferred) can you tell which is the most used/the preferred method?
e. Is it possible to tell a precentage of how certain methods relate to the fields the customers work in? Werden bestimmte Methoden von bestimmten Branchen bevorzugt?

❑

6. Marketing

a. What marketing instruments do you use? (For selling beamtime as well as for attracting industrial users) How important is each instrument for your institution (1-6)? – Are there special conditions or informations regarding these instruments?

Instrument	Used Yes/No	Evaluation 1-6	Special condition /information
Website			
Flyers & Brochures			
Presentations and visits at industry fairs			
Presentations directed to industry at workshops / conferences			
Booths at fairs and conferences			
Free tests and method evaluation			
Rate deductions			
Research cooperation agreements			
Other (specify)			

7. General administrative framework and obligations

a. Is there a special institute's policy of whether industry
   i. has to be granted a certain minimum amount of beamtime? – yes/no
   ii. may use some Beamlines to a certain percentage? – yes/no _____%
   iii. Did the policy change during the last years?

b. Are there dedicated beamlines for industrial use only?

c. How do the following people judge industrial use on a scale of 1 – 6
(1 = completely unnecessary; 6 = mandatory for your institution)
   i. Government sponsors (if existant):

   ii. Management of your institution

   iii. Employees:

d. What factors help industrial use at your institute? What factors are blocking industrial use?

8. Industry view

a. Are there certain elements (methods, knowledge, marketing etc.) which make your institution outstanding or unique for industrial users, if compared to other synchrotrons?

b. Please name us five typical industrial users for a short interview regarding their customers view towards a synchrotron.

i. ______________________________ is a typical user because ______________________________

ii. ______________________________ is a typical user because ______________________________

iii. ______________________________ is a typical user because ______________________________

8.4 Questionnaire Industrial Users of Synchrotron Radiation

Thank you for taking time for the ERID-Watch project. We very much appreciate your input. The data gathered with this questionnaire will not be published in this form in the ERID-Watch report; a summary of conclusions that we draw from the data might be published, but not unless we have your written consent, after you received and reviewed the interview results.
All data will be treated as confidential.

Name of the Company: Address: Country:
Name: Department: Position: Tel.: E-mail:

Evaluation Scheme used for grading questions

1 = very bad

2 = bad

3 = slightly below average

4 = slightly above average

5 = good

6 = very good

2. Did you use more than one synchrotron in the last years?
If yes, why?

3. Which Synchrotrons have you used in the last 3 years?

1.

Synchrotron	Institution	Address

4. Evaluation of each used Synchrotron

Synchrotron►			
Question ▼			
Is it possible to book service yes/no			
What type of service? Full/partial?			
Quality of Service 1-6			
How good is the support in general? (With or without bookable/booked service?) 1-6			
Is it possible to book beamtime on short notice? yes/no			
How easy are formalities? 1-6			
How do you assess the price/ performance ratio? 1-6			

5. Important Aspects of Synchrotrons

How important is the distance of a synchrotron to your company? 1-6	Do you need beamtime on short notice? Yes/no	Do you need full service? Yes/no	Do you need service at all? Yes/no

6. Which is the most important measurement method for you?

7. How would you describe an ideal service at a synchrotron for your purposes?

8. How well are you informed about other lightsources, e.g. FEL?

9. Do you have plans to use other light sources?

Would you like to be informed about the possibilities other light sources offer? If yes, in what way?

	Yes/no	Comment

Email		
Flyer		
Website		
Presentation on fair?		
Other?		

10. Is there someone else from your company whom we should contact regarding the present topic?

11. Do you know off-hand any other companies (in your field) that might be possible users? Is there anyone specific we should contact?

12. Do you know companies in your field that do not use synchrotron radiaton? If yes, do you know why?