ERA Instruments

Mid-Size Instrumentation in the Life Sciences:

I. Efficient Operation and Access

Imprint

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Preface

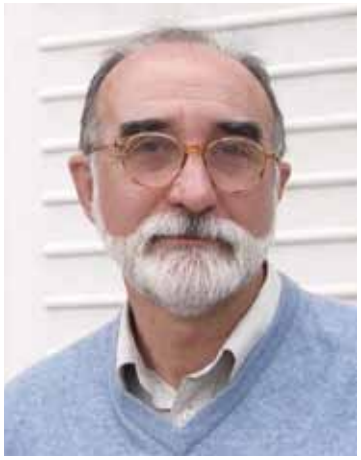
ERA-Instruments is a European project bringing together funding agencies, ministries, charities and research performing organisations to aid in establishing centres for mid-size research instrumentation that meet the needs of the scientific community.

Workshops, meetings and further stakeholder consultation have led to a wealth of results and conclusions that we present as a series of publications under the heading of "Mid-size Instrumentation in the Life Sciences". The first topic is "Efficient Operation and Access".

ERA-Instruments has assembled key issues that should be taken into account when operating a research facility that is offering access and providing service to external users. The focus is on mid-size centres in the life sciences, but many aspects apply to other scientific areas and to larger facilities such as those determined by ESFRI. The results presented in this paper originate from various discussions with funding organisations, research institutions and the scientific community. This paper is not intended as a prescription of how to run a facility, but is meant to provide a basis for discussing operation and access for various individual scenarios that all need to find an efficient and viable mode of operation. The paper is addressed to facility managers, scientists and funding organisations.

Foreword

By José L. Carrascosa, Chairman of the Scientific Advisory Board of ERA-Instruments



"This report focuses on the growing importance of mid-size instrumentation for scientific research, with special emphasis on the role of the access to this type of cutting edge instrumentation for the advancement of life sciences. Based on a well grounded experience developed over recent years, the different issues have been discussed from different perspectives, including the cumulated experience of active researchers, the working mechanisms of granting agencies, and the overall view provided by policy makers. It is this unique blend of experiences what makes this document a valuable update of our common feeling on how the investments in leading instrumentation might be optimized for an improved advance of the European Research Area.

The fundamental importance of standardised access rules, the type of offered services, the appropriate maintenance and replacement of equipment, the definition of the careers of the scientific and technical personnel related to these infrastructures, among others, are critical aspects that should be carefully considered, as they become instrumental factors for the eventual success of the service to the scientific community. We sincerely hope that these reflections might be of interest for funding organizations and facility managers not only in life sciences, but also in many other areas."

Content

Summary

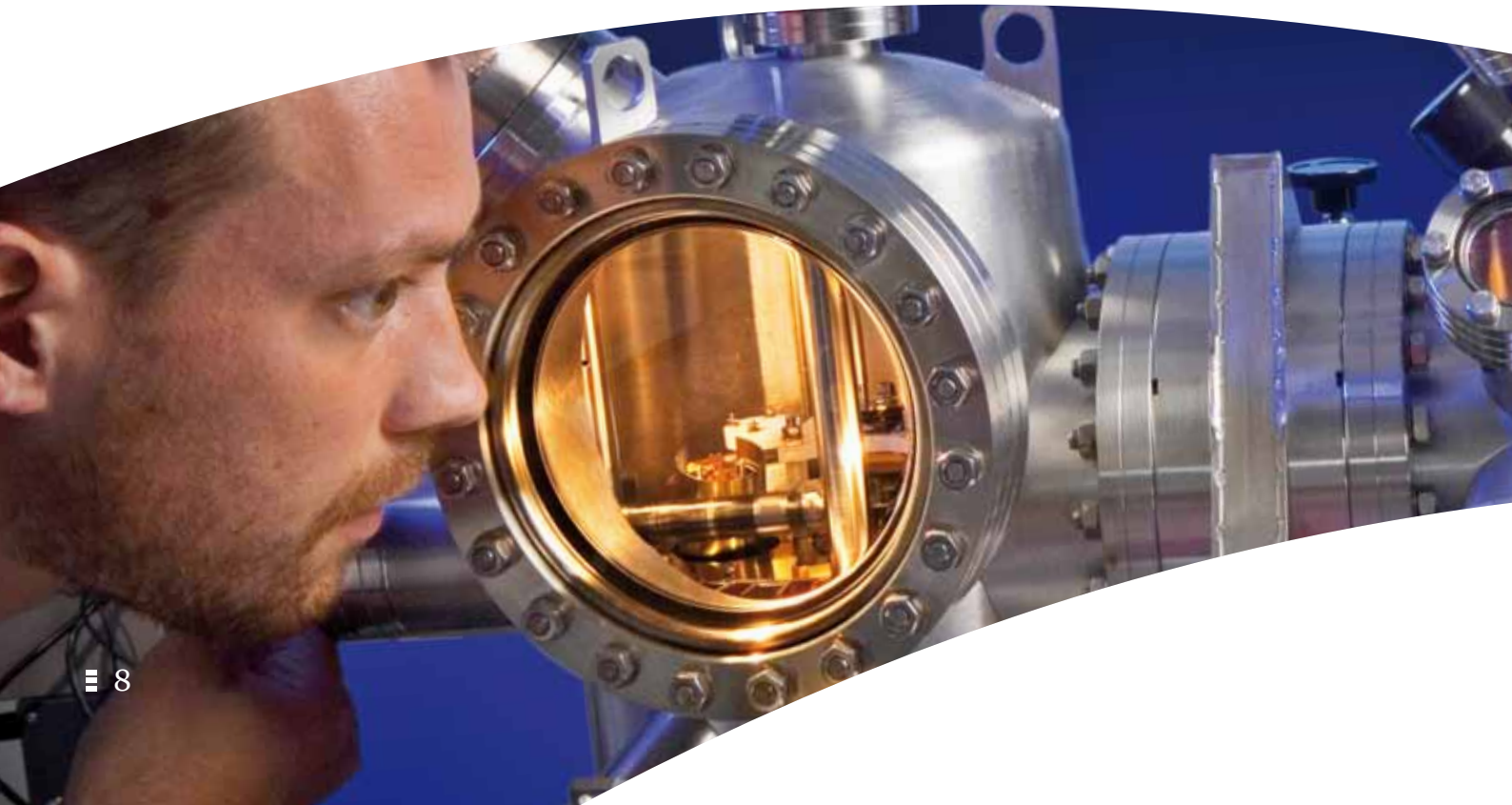
There is an increasing tendency to run mid-size instrumentation in core facilities that provide valuable service to the scientific community. This document assembles a number of recommendations that appear relevant for research facilities which are open to external users.

To begin with, it is obvious that experience with the experimental methods as well as data treatment is indispensable, because the availability of cutting edge instrumentation does by itself not guarantee high quality research. But shared facilities need to balance a high quality research programme with scientific service to their users. The ability to attract high profile users and projects is the best proof of excellence. Overbooking would be the usual case and suitable selection procedures for proposals requesting access need to be established.

While the expertise of the core staff at the facility is essential for it to operate, sharing of expertise in form of courses and training at the facility would be desirable as well. Data analysis, but also access, transfer and storage of the primary data are very important.

Centres of excellence can develop best practices which are then passed on and distributed. For a smooth interaction between facility and user, information on access conditions must be easily accessible and potential legal or practical problems should be clarified early on. The majority of the life scientists appear to be in favour of a graded user fee model, in contrast to the physicists' community. Additionally, exploiting available research instrumentation in companies by academic researchers might be beneficial to both sides.

Decentralized or distributed research infrastructures that comprise many relatively small centres instead of one very large facility are increasingly recognised in their relevance for establishing the European Research Area (ERA). One aim of the recommendations is the implementation of quality standards for mid-size facilities across Europe.



What is mid-size instrumentation?

Research instrumentation can generally be divided into three classes, of which the small and the large scale are easily explained and defined:

Small scale: Instrumentation of local relevance, e.g. lab equipment; this is instrumentation that is typically owned and operated by single laboratories. Organisation of access is purely on the local level.

Large scale: Instrumentation, or rather facilities, of pan-European relevance; such a facility is typically unique in Europe and serves the whole European, or even international scientific community. Typical examples are known from physics, such as CERN, ITER and ESFRI projects, for instance FAIR, XFEL. ESFRI isn't restricted to instrumentation, but has a broader understanding of research infrastructure, including also distributed resources, such as bio banks (BBMRI) and data bases (ELIXIR) or even the European Social Survey (ESS). Large scale facilities require typically an individual and multinational organisational structure and funding agreement.

Mid-size instrumentation lies in between the small local and the large pan-European scale and a sharp distinction either on the lower or the upper limit is difficult. Nevertheless, in the life sciences mid-size instrumentation is at the heart of scientific progress in many fields. This comprises pieces of equipment, such as electron microscopes, nuclear magnetic resonance (NMR) and magnetic resonance imaging (MRI) scanners that have become so elaborate and technically challenging, as well as expensive, that not every laboratory can possibly have its own. Alternatively, single instruments might still fall in the small scale category, but typical settings would include a larger number of pieces, as is the case in genomics or proteomics platforms. These can be as a whole of at least regional relevance and attractive to external users, particularly when the facility can provide special expertise. These examples suggest that life science research is increasingly dependent on the mid-size instrumentation. Typical costs for mid-size instruments range between 0.5 and 20 million Euros.

What is a research infrastructure (RI)?

The term "research infrastructure" (RI) comprises a broad variety of facilities, resources or services that are needed by the research community to conduct research in any scientific or technological fields. The following definition is similar to those used by ESFRI[1] and the European Commission[2] and covers, including the associated human resources,

- Major equipment or group(s) 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 entity of a 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". This includes singular large-scale research installations, collections, special habitats, libraries, databases, biological archives, clean rooms, integrated arrays of small research installations, high-capacity/high-speed communications networks (e.g. Géant), networks of computing facilities, research vessels, satellite and aircraft observation facilities, coastal observatories, telescopes, as well as infrastructural centres of competence which provide a service for the wider research community based on an assembly of techniques and know-how.

[1] *ESFRI defines RI e.g. in the ESFRI-Roadmap 2008, page 10, on http://cordis.europa.eu/esfri/*
[2] *The European Commission describes RI on http://ec.europa.eu/research/infrastructures/*

Instrumentation and research infrastructure

There is a clear tendency in life sciences to make shared use of instrumentation and to run it in centres like core facilities. Once such a core facility has grown to a certain size and developed an organisational structure, it is quite reasonable to consider it a research infrastructure.

The resulting research infrastructures may or may not grow to the level of a mid-size facility. So far there are no agreed criteria to mark the transition from local to mid-size RI and the factors promoting or hindering the foundation of mid-size centres need to be investigated more deeply.

Problem:

- Life scientists generally do not have the tradition to work in shared central facilities.
- Mid-size instruments are usually bought, when possible, by each single institute or laboratory. This practice has many disadvantages (economically, but not only).
- A major hidden cost is often associated with acquiring the know-how to run the instrument successfully, not the investment of the instrument itself.

Recommendations:

- Promote the visibility of user-friendly centres that offer shared access, e.g. by a public inventory.
- Develop funding strategies encouraging life scientists to carry out part of their experiments in national or European facilities.
- Actively inform young scientists about new experimental approaches relevant to their research based on the use of leading edge instrumentation.

Efficient operation of and access to research infrastructure (RI)

Whatever the history of a centralized facility may be – whenever a facility is shared in the sense that it serves several research groups, its profile and the organisation of operation and access become relevant. Therefore, **shared facilities need a professional management for efficient operation.**

Scientific basis and profile of a mid-size RI

Shared facilities need to ensure they continue to offer cutting-edge technology to their users. Facility development, engagement with technology providers and an appropriate cost-recovery model should all be explored by facilities to ensure they continue to meet the technology needs of users.

Shared research infrastructures and facilities need to retain a high quality research programme alongside the service provision function, in order to retain the facility's cutting edge technologies and to ensure retention of appropriately trained personnel. To this end advanced technology research facilities need to be integrated in a research environment addressing well-defined scientific problems.

The physical location of a facility should be defined in relation to the users' needs and the available RI. The establishment of new facilities should take into account, and make use of existing physical and social infrastructures. New shared facilities should be integrated with these infrastructures wherever possible. Where this is not possible, a robust outreach plan should be in place from the outset to ensure maximum take-up of the shared facilities.

Because the classification as RI is primarily based on the potential outreach to external users, not only size, technological specification, or cost of equipment is decisive.

Specialization and expertise in a topic can make a centre outstanding even if the equipment itself is not. Such facilities with very special research focus might serve a very distributed albeit small community and thus might attain transnational impact.

Further, centres may be based on a research topic rather than the kind of equipment available. These integrated research facilities do not merely concentrate on a single technique but rather comprise all necessary instrumentation and labs for the dedicated purpose in order to offer an integrated approach for supporting life sciences appropriately. They might make key technologies available where they are not (yet) provided by the market and can review changes in technology and on the supply side regularly. Structural biology and the related ESFRI project INSTRUCT might be an example where the integrated approach can offer substantial benefits.

Granting access must be more than providing measurement time

Efficient use of instrument time is of paramount importance for running a shared facility successfully. Efficiency cannot be measured by the number of users or experiments alone. Especially for highly sophisticated RI the availability of cutting edge instrumentation does by no means guarantee high quality research. Adequate sample preparation, expertise and experience with the experimental methods as well as data treatment are indispensable components for successful and efficient use of measurement time. Shared facilities need to clarify with external users at an early point what level of support or training the facility can offer. Only if this meets with the requirements of the user, further planning should commence. **Information on access conditions must be easily accessible.**

The expertise of the core staff is essential for the facility to operate. However, an appropriate balance between independent research and service provision is required to ensure that highly-trained staff are recruited and retained. Often there does not appear to be clear career progression when researchers are providing scientific service rather than conducting their own research. Managers of facilities should try, wherever possible, to recognise the career requirements of instrument scientists and technical support staff when developing the work plan and staffing profile of the facilities. Exchange programmes for instrumentation scientists between centres of the same kind and, potentially, with user groups can be fruitful.

Offering of courses and training at the facility is important for regular users and for novice instrument scientists. A decision should be made whether to provide mandatory training for novice users or whether to run users' samples as part of the service. In the case of simple or automated equipment, running samples on behalf of the user may be the most efficient method. But it is important to note that access can be limited due to shortage in available personnel of the centre and not in instrumentation.

In the life sciences, basic laboratory space for immediate experimental set-up is essential, but it is less clear whether a full sample production laboratory is needed at the site of the instrumentation. Instead a dedicated facility for sample production separated but linked to the RI might be more appropriate.

Offering access to facilities for sample preparation can be resource intensive and problematic where diverse sample types are expected, but it will provide considerable benefits to the user and, thus, can be beneficial to the competitiveness of a facility.

Assistance with analysis of data is important and provides similar benefits to the user, but can be less resource-intensive than sample preparation. Trained and experienced research staff is required to analyze data as part of a service, but, again, needs to be motivated in order to be actively involved. Basic services like data access, transfer and storage are very important and should be provided by every facility. User training for the appropriate software is recommendable.

Unfortunately in many fields of the life sciences, software packages for data analysis are often individual solutions lacking standards and unified file formats. Proprietary software of equipment providers can be an additional major hindrance in this respect.

Application procedures for obtaining access

User friendly interfaces are considered a prerequisite for easy access. Online portals provide a convenient and efficient means for applying for access and can provide initial information regarding sample conditions and available experiments. Some form of feasibility checking by the centre is common practice.

RIs that are attractive to the scientific community will usually be overbooked with requests for access. This makes fast and efficient procedures necessary that select for the most promising or relevant proposals. Appropriate allocation of both equipment and time has to be made when different equipment specifications are available.

Applications should be judged against the criteria of scientific excellence and timeliness, taking into account technical feasibility and safety issues. A frequently used option is block allocations for large projects or user groups to give them flexibility within their blocks.

An external control of the application and selection procedure is desirable.

Financial models for operational costs

Financial models including charging user fees will depend on local circumstances and can range from free access to full cost-recovery. Facilities that are free to the user at point of access can only really be supported if sufficient institutional funds are available, for example in facilities funded by subscription, like ESRF. Full costing models would provide the maximum financial flexibility for a facility, but may result in a lack of competitiveness. Potentially, this could be offset by offering data analysis or sample preparation.

Funding schemes should foresee an option for including user fees in project proposals, potentially in the form of vouchers that can be granted. Facilities funded through central or national schemes may be expected to offer reduced cost access to 'home' users funded by the same organisation. Low cost pilot studies should be offered allowing users to perform feasibility checks on their projects.

The European Commission should provide additional funding for users of mid-size or larger research infrastructures similar to the existing transnational access scheme. This funding should not cover all costs, but rather give an incentive to use existing facilities within Europe.

The users should additionally pay a fee for use of the facilities, which increases commitment. Travelling should only be supported where necessary. A major shortcoming of the existing scheme is that access of a scientist to facilities in the same country cannot be funded and this gap obviously needs to be filled.

ERA-Instruments' analysis suggests, that the majority of the life scientists is in favour of a graded user fee model, where users from industry pay full costs while academic groups contribute to running costs with more moderate fees. This is in obvious contrast to the physics community where the free access based on fast-track evaluation (locally by the RI) of applications for measurement time is favoured[1].

A likely explanation and justification for this difference is that large facilities as they are typical in the physics community are well visible and can attract sufficient institutional funds whereas the smaller and distributed life science RI facilities often do not find sufficient financial support to provide free access to external users. The ESFRI projects in the biomedical section might be a first step towards recognising the requirements of distributed RIs also on the political level.

Money should not rule science, but obviously financial considerations will influence many aspects of providing access and service. Therefore, it might be desirable to identify and present successful financial models for running mid-size facilities in more detail albeit not in this paper.

[1] *See e.g. http://www.europeanresearchfacilities.eu/home.aspx*

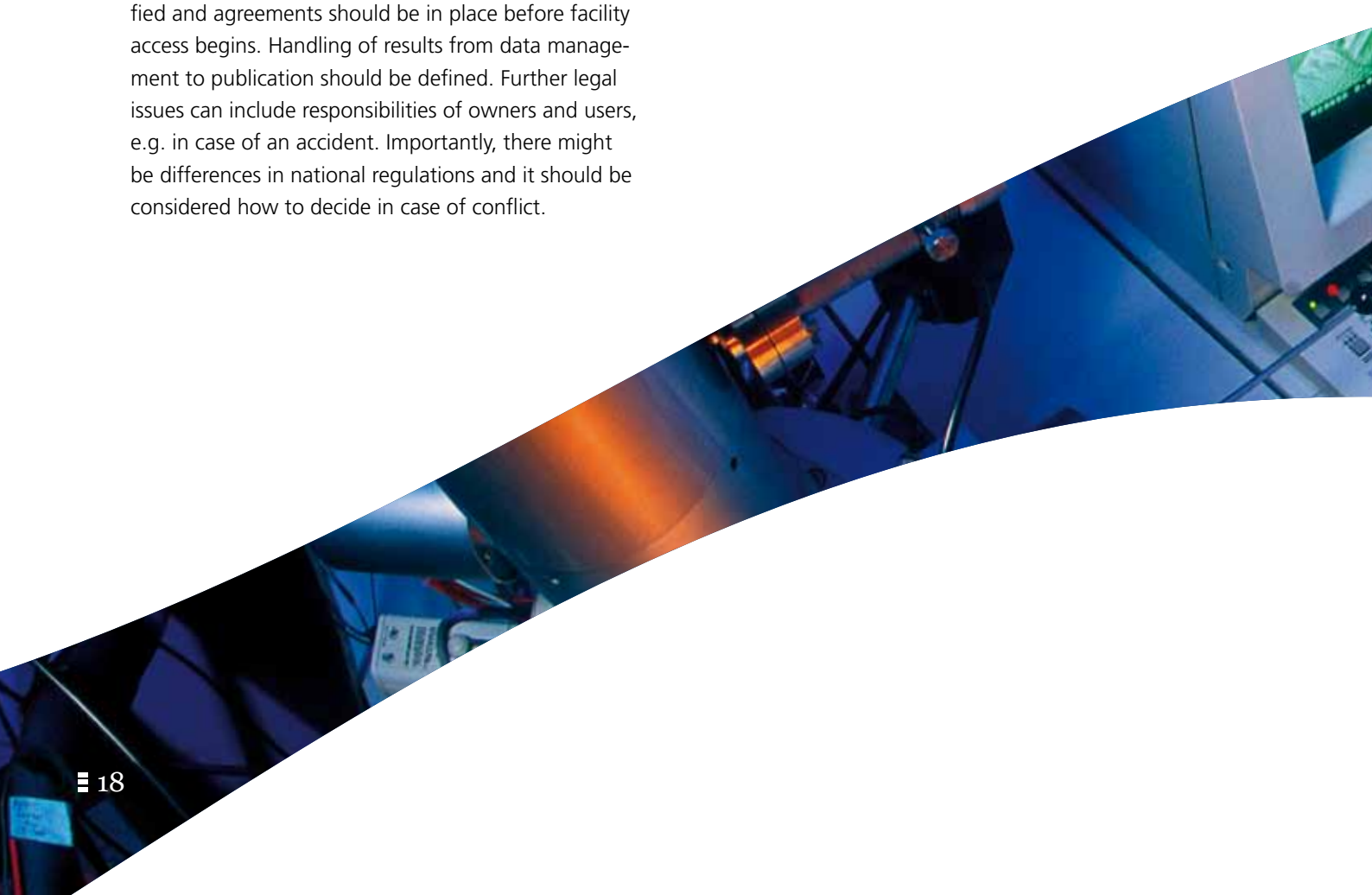
Legal and practical concerns

Contact should be made as early as possible with facility managers to clarify what the costs are, in what form samples should arrive, and how much help and training can be expected for sample preparation, instrument use and data analysis. Users should be prepared to handle specified data sizes and formats.

It is the responsibility of the user to ensure that the sample arrives in a format ready to use. This can mean ensuring safe transport, that the sample is in the correct form or mounted and prepared correctly, and compliance with local regulations. Sample transfer across borders can be a problem and RI centres should know about national regulations and advise users. The same is true for ethics regulations. Automation, remote access and even remote operation are increasingly developed and can solve some problems of logistics.

Projects involving intellectual property should be identified and agreements should be in place before facility access begins. Handling of results from data management to publication should be defined. Further legal issues can include responsibilities of owners and users, e.g. in case of an accident. Importantly, there might be differences in national regulations and it should be considered how to decide in case of conflict.

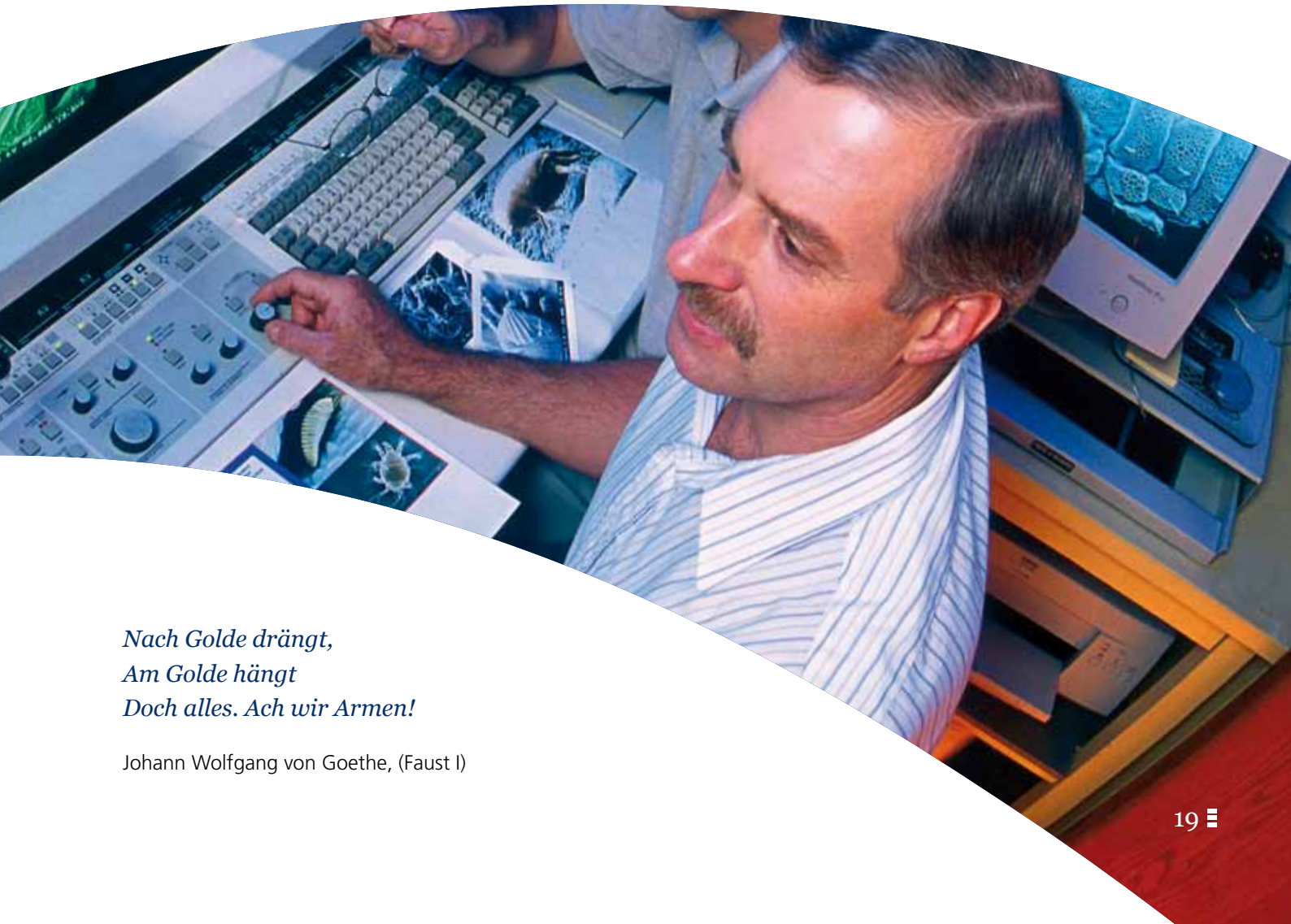
For publications co-authorship for members of the facility staff is only warranted when substantial scientific input of that person contributes to the publication. Just providing the instrumentation and service is not sufficient for a co-authorship. Nevertheless, use of a facility has to be acknowledged in appropriate ways, e.g. in the acknowledgement section of a publication. Users may be obliged to inform the facility managers about publications based on data generated at the facility. Funding organisations have to find appropriate ways to count these kind of acknowledgements as valid indicators for a vivid and productive use of the instrumentation when evaluating investments or deciding on renewal/extension proposals for running facilities.



PPP - Access to RI in industry

Modern and expensive equipment is not only required in many areas of basic life science research, but also in R&D departments in industry, sometimes even in quality control steps. Both, industry and academia, share the desire for latest cutting edge technology and the restriction by limited financial and human resources. Therefore, one would expect that resources could be pooled and access could be shared. Full cost recovery financial models can be employed in order not to mix funding streams.

Agreements on intellectual property and non-disclosure are required. While the use of instrumentation at research facilities by companies is common practice, the opposite way, i.e. access of academic researchers to a company's RI, is only rarely explored. But **exploiting available RI in companies by academic researchers might be beneficial to both sides.** There appears to be no reason, why a company's RI should not be able to be operated like an RI facility as discussed in the previous sections with a suitable financial model.



Nach Golde drängt,
Am Golde hängt
Doch alles. Ach wir Armen!

Johann Wolfgang von Goethe, (Faust I)

Conclusions

While this paper describes some fundamental aspects of providing and gaining access to RI in the life sciences, it is clear that many minor and major differences exist between different kinds of RI and for different organisational structures that provide access. This diversity may be an asset for exploring, evolving and defining best practice models.

Irrespective of all variability it is clear that procedures and conditions for obtaining and exploiting access to an RI need to be clearly defined. The framework provided here will hopefully provide some help and guidance in deriving adequate solutions for finding best practice models for mid-size RIs in the life sciences and beyond.

About ERA-Instruments

The programme

It has become increasingly obvious that concepts and strategies for research infrastructure (RI) funding should be harmonised and coordinated within the EU. ESFRI has determined requirements for European RI funding and has presented a roadmap. Growing attention is paid to life sciences that rely on RIs of a less centralised, but more networked dimension. There is a clear need for action in the interdisciplinary area between physics, chemistry, biology and medical sciences as cutting edge instrumentation becomes increasingly expensive and, yet, indispensable for world-class research.

However, promotion of research policies, apart from the ESFRI projects, has been restricted so far to national efforts without managing these actions with a European view. Funding and research organisations cannot afford to remain at the national stage with world-wide competition for the best scientists and the most promising projects. Frontier research is international since long and funding organisations have to follow scientists to the European level.

The ERA-Instruments website

www.era-instruments.eu

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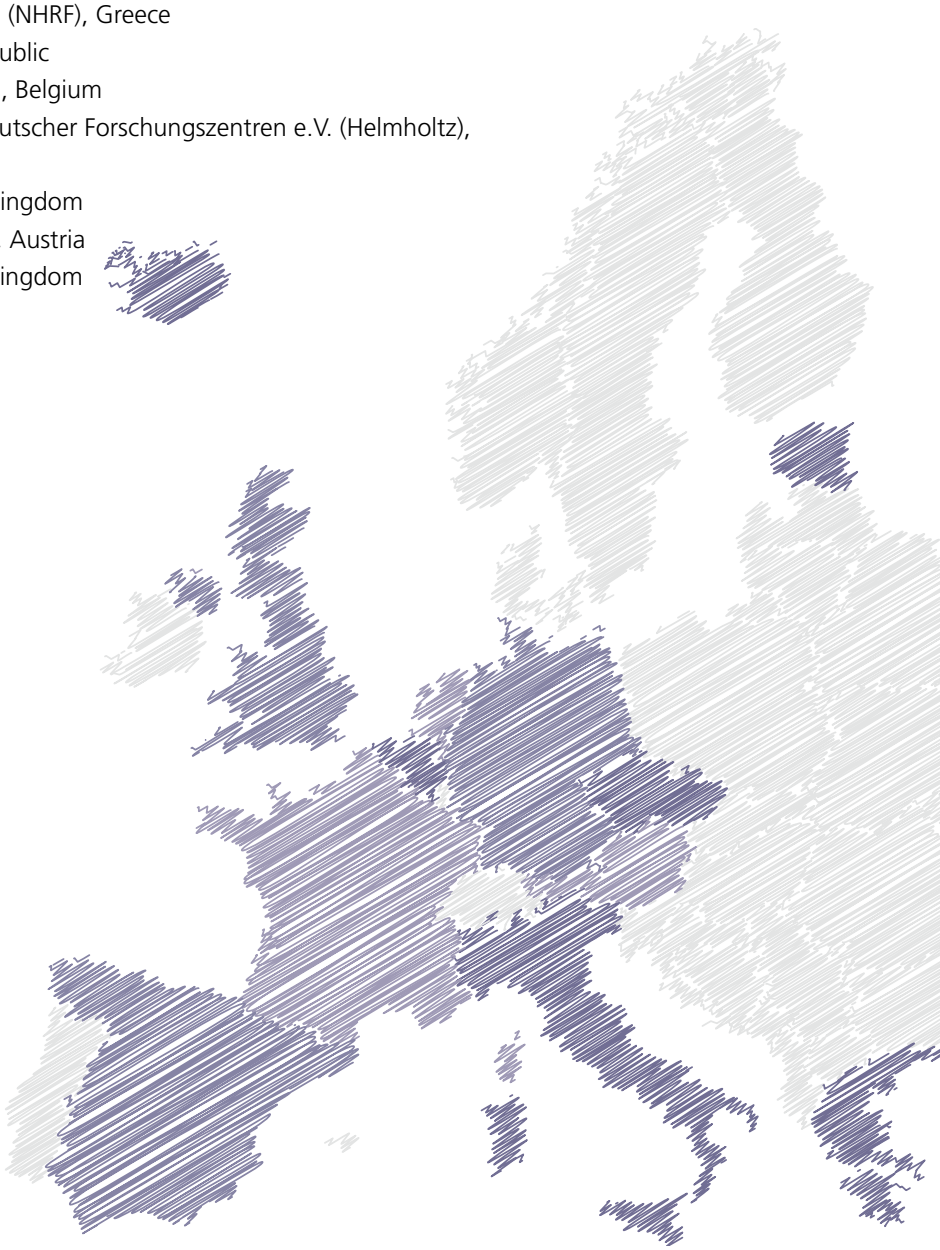

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