Central European Research Infrastructure Consortium (CERIC)

(www.ceric-eric.eu)

Technical and scientific description

of the distributed research infrastructure

that CERIC will establish and operate

Abstract

Due to the historical events of past century, Centre East European Countries have had fewer opportunities to invest in large research infrastructures and develop them at pan-European dimension.

CERIC (the Central European Research Infrastructure Consortium) aims at contributing to a speedy and cost-effective catch-up of this Region in the field of analysis and synthesis for advanced materials and life sciences with a Research Infrastructure of pan-European quality and relevance. This initiative is open to other Countries capable and willing to contribute to the common goals.

CERIC builds on existing investments in high quality, complementary, regional and national facilities, and its added EU value is achieved by integrating and upgrading them into a unique EU-level distributed infrastructure. This approach is made possible by building on the experience, mutual understanding and trust, previously developed in the long-time integrated operation of several of these infrastructures, and on the collaborations between different Institutions and Countries in the Region.

The Governments of Austria, Croatia, the Czech Republic, Hungary, Italy, Poland, Romania, Serbia and Slovenia have agreed to set-up CERIC. They contribute “in kind”, by making available the access and use of existing and new planned facilities and resources, to be integrated into a common research infrastructure capable of offering high-quality Analysis and Synthesis services for research. This access will be open and free of charge for users selected by peer review only, not only from the Region but from anywhere in the world.

The availability of a Research Infrastructure offering a single, coordinated access to different probes and techniques for research in the field of Advanced Materials and Biomaterials responds to a growing requirement at international level, and CERIC will be unique at European and world level for the range and quality of offered techniques.

CERIC will have a single Governance empowered to make the facilities available as an integrated and coherent service to external users, while improving the services offered, to attract and host researchers at global level. The aim of this “open-access integrated operation” is to increase the return of national investments by building a competitive environment for research, education and industry in a coherent and ERA oriented way. CERIC will be able to directly acquire, in a competitive way, resources in the international environment, which will be invested in the upgrade of facilities and services.

Contents

1. Introduction

The proposal of establishing CERIC as a distributed Research Infrastructure, as defined by the European Strategy Forum for Research Infrastructures (ESFRI) within the framework of Pan-EU and of Regional Facilities, was inspired by the discussions and indications developed within ESFRI, in particular in its Regional Working Group, and at various levels, such as in the ECRI Conferences and the Competitiveness Council. It has taken its specific form in the meetings of the Research Ministers of the Centre-East EU and in the meetings of the Salzburg Group and of the Central European Initiative. The Governments that have formally agreed to develop this idea by setting-up a specific Working Group[1] are: Austria, Croatia, the Czech republic, Hungary, Italy, Poland, Romania, Serbia and Slovenia. The CERIC proposal is the outcome of this preparatory phase.

As agreed by the founding Governments (the Parties) CERIC has two main missions:

- to provide research in materials and life sciences with a unique multidisciplinary Research Infrastructure (RI) of Pan-EU and international relevance, operating in the context of the European Research Area.
- to help the catch-up process of the scientific communities in the area, involving them in setting-up and operating this Pan-EU Research Infrastructure, and thus acquiring the capability and training to compete at international level both in terms of research quality and of generating socioeconomic returns.

CERIC includes one Partner Facility (PF) for each participating Country, and its EU added value is achieved by integrating and upgrading them to offer a unique capability to international users as a single "service facility". The PFs are already operational or planned, and their joint operation and access will increase their value and outreach at international level. PFs are proposed by each Country and accepted after international evaluation. Each PF will also have the task to act as a reference for the nearby Region and to connect with the national and regional research centres. Evaluations of each PF and of the central services of CERIC will be performed regularly to ensure quality and effectiveness. The first set of PFs proposed by the Parties is briefly presented in Annex 1, with more details available in their web-sites.

[1] The Working Group has been set-up in February 2011 in Wien, and has worked on the basis of a MOU signed in Bregenz in June 2011 in connection to the "Salzburg Group" meeting and in Trieste in October 2011 in connection to the CEI meeting of Research Ministers.

CERIC's scientific services will be planned with reference to the quality criteria for Pan-EU RIs developed by ESFRI.

The CERIC distributed infrastructure will be a single legal Entity, offering:

- a common, web-operated access point describing and offering the available integrated services;
- a common entry point for users proposals and a common evaluation system to select them and allocate access time to multiple instrumental facilities;
- free and open access to these facilities based on quality selection only;
- support and logistic services as required;

Its Governance will consist of:

- a General Assembly developing a common strategy and defining implementation plans for the integrated facility;
- a Board of Directors in charge of the joint integrated operation of the facilities and of increasing the outreach and use of its scientific and technical capabilities both for Science and for Society.
- an International Scientific and Technical Advisory Committee (ISTAC) to monitor the quality and strategic coherence of the CERIC activities and planning, advising the General Assembly and the Board of Directors.

The General Assembly is composed by the Parties that can appoint, as Representing Entities, the Institutions owning the facilities. The Board of Directors is composed by the Directors of the Partner Facilities who, by statute, must have the power to direct the facilities needed for the operation of CERIC. The Statute of CERIC requires that the Assembly and the Board of Directors take into account the advice and the scientific evaluations by the ISTAC.

The founding Parties of CERIC are Central-East European Area Countries and Regions[2]. This initial geographic focus is due to a long tradition of collaboration and trust between them, and to their will to improve the competitivity of the area. However, CERIC is open to other partners that are willing and capable to contribute to the common effort. Prospective Parties, (e.g. Countries still developing appropriate partner facilities) and Countries involved within CERIC in joint projects with specific scope and time scale may become Observers in CERIC.

CERIC will build on the scientific quality of the Institutions operating in the Central-Eastern EU area. This will contribute to speed-up the efforts to reach the same level of capabilities already existing in other parts of the EU, ensuring the growth of excellence for a wider scientific community, including the development of the science and science-driven technology basis of the European Research Area.

2. Necessity of CERIC for the carrying-out of European research programmes and projects

CERIC responds to two main needs for European Research: maintaining and strengthening cutting edge competitivity in a relevant scientific field, and speeding up the involvement of all its human resources in advanced, competitive research and innovation.

CERIC will operate in the wide research area of nanoscale analysis and synthesis for Materials Sciences, including areas linked to Biomaterials and Structural Biology. This overall scientific area is a basic

[2] The involvement of the Italian government has been particularly supported by the Regional Government of the Trieste area, which has a strong Centre-East EU orientation.

component and a strategic contributor to European competitivity, being directly connected to the support of product quality and innovation in manufacturing, biomedical, chemical and other industries.

Analytical capabilities made available by the PFs span lateral resolution at the nanoscale or even at the atomic level, based on complementary probes (electromagnetic waves, neutrons and electrons) while synthesis techniques cover the range from physico-chemical to biochemical methods. Time-resolved techniques will also reach time definitions comparable to atomic and molecular processes, in the femtosecond domain.

CERIC focuses on the increasing necessity, by Materials and Life Sciences Research, to offer the capability to analyze and characterize the same material with several complementary probes and techniques, and also to manipulate different aspects in its synthesis and preparation. The competitive advantage of CERIC will be the capability to offer, in an integrated way and at international level, access to top-quality probes and to a large inventory of different characterization and preparation techniques.

So far, users were required to apply at different laboratories and undergo different uncoordinated peer review evaluations to be able to perform a single complete study. CERIC will provide coordinated and specifically designed access to the needed set of complementary methods and instruments. Such a research infrastructure is not available anywhere else in Europe and, as far as we know, in the world. Although there are examples of specific sites offering access to some of these methods, these are independent, not coordinated laboratories (such as the ILL and ESRF in Grenoble or ISIS and DIAMOND in Oxfordshire). CERIC will focus specifically on scientific problems in which a multi-technique approach is required and, when properly implemented, gives a competitive advantage.

By involving research centres in nine Countries into an integrated and world competitive effort, CERIC will also involve a large number of researchers and technicians in a more competitive environment, and will help local institutions to develop the best approach to attract and use the outcomes of science-driven innovation and education.

Analytical facilities for Materials Sciences capable of nano (atomic) level definition are based on the use of probes able to sense single atoms/electrons/nuclei: these probes are *Electromagnetic waves* from radio to ultra-short wavelengths in the hard X-Rays region (with techniques ranging from NMR and photon spectroscopies to microscopies), *Electron*s (in high definition transmission, diffraction or reflection microscopies), or *Neutrons* (in scattering and or transmission spectroscopies). Other more specialized probes (*protons, muons, positrons*, etc.) are used in particular cases but are not planned at present within CERIC. The equipments used in the analytical facilities consist typically of an advanced-quality source of the appropriate probe (from high RF frequency/high magnetic field NMR to high photon brilliance synchrotrons and free electron lasers, and to high flux-slow neutrons) connected to measuring equipment which allows to fully exploit the quality of the source and to collect the relevant data produced by the interaction between the probes and the materials under study.

Synthesis facilities for material preparation at the atomic level of control are a wide class, ranging from physico-chemical to chemical assembly (e.g. from vacuum deposition to sputtering, laser ablation, molecular epitaxy and chemical structuring) to biological selection and assembly (e.g. PCR production of proteins). These are typically referred to as "sample preparation facilities", and are a very important asset when properly connected to analytical facilities, e.g., bio-crystallography laboratories including the growth of protein crystals.

The prospective Partner facilities of CERIC together provide most of the techniques listed above, including a "theoretical support group", to develop appropriate theoretical and computational instruments.

New facilities are being built and/or planned in Poland, Serbia and Croatia, and upgrades are planned for the already operational facilities. CERIC will help to develop a strong coordination between these new investments and obtain a more effective and competitive result.

The facilities offered are the best ones selected in terms of quality. No *a priori* selection of the types of infrastructures and of the topics to be proposed by the perspective users was done. This is based on previous experience in planning and designing multidisciplinary analytical facilities (like synchrotrons and neutron facilities) which has proven that in most cases the requirements and the science fields proposed by new users exceed by far the advance planning and imagination by facility builders. Indeed most of the users of ESRF in Grenoble or of Elettra in Trieste were not anticipated during the design and construction phases, albeit the design studies involved all major experts in the subject. The new CERIC distributed facility starts with the ambition of increasing the value and the use of a far wider, and already existing, high quality instrumental endowment.

Excluding the possibility of new and unexpected users coming forward would risk to decrease the potential of a positive impact.

We plan a more empirical approach, following closely the responses of the users, while investing in the training of a younger generation of researchers who will have open access to these capabilities and will have a fresh outlook in combining the available techniques while approaching existing and new problems in new ways. For this reason one of the first initiatives of CERIC will be to organize, from the first year, schools and training activities to take place involving the different PFs, to expose present staff and junior people to the variety of instruments and topics already available and to be further developed, with the view of stimulating cross-fertilization and new ideas.

Concentrating on few scientific fields would go counter the experience gained in the previous analytical facilities, and risk to limit the very fertile cross-disciplinary interaction which has been driving the development and improvement of analytical and synthetic techniques in multidisciplinary facilities. The ERA does not necessarily need to be "structured" along present disciplinary divides, but should take stock of the potential of cross-and multi-disciplinary approaches, as required by the need to face the grand challenges.

CERIC builds on a strong foundation: the PFs have already been developing and operating international-level facilities and capabilities, with equipment and staff dedicated to the support of external users, and have achieved extensive response from international user communities, especially in the NMR, synchrotron/free electron laser, and neutron facilities.

Moreover, the integration between the Partner facilities is based on previous successful experience. Several of them have already operated in an integrated way and/or in extensive collaborations. For example the photon beamlines and measuring stations built by Institutions in Austria, the Czech Republic and Slovenia have successfully been operating within the Elettra facility in Trieste as "in kind" participations based on the equipment and personnel of the home institutions. These earlier experiences already produced a growing outreach to the Central EU scientific communities and a strong and increasing response from the scientific users also beyond the specific Countries involved.

The collaboration between different technicians and scientists from the different countries and facilities, who must co-operate in an harmonized way to respond to the requirements of users, and integrate techniques they are not initially familiar with, will train and educate a new generation of scientists and technicians to operate with a problem-solving attitude.

3. Added value in strengthening and structuring of the European Research Area (ERA)

In the past century, the Central European Region has had fewer opportunities than other parts of the world to invest in large research infrastructures of pan-European dimension, and a speedy re-alignment of this Region with the "older" EU Member States is essential for Europe as a whole, to fully exploit its human potential in view of the fast growth of other large Nations (India, China, Russia, etc.).

In the present financial and regulatory circumstances, to launch new initiatives requiring large investments is bound to give results only in the longer term, while a faster and more effective approach can be implemented by improving "national" investments, already existing and/or planned, which, without an international approach and competitive drive, would not have a Pan-EU impact.

The approach adopted by CERIC and supported by the founding Parties is to start a process enhancing the quality and returns of available resources, and obtain results greater than the simple sum of the contributed parts. The main driver will be the opening to international competitive access, to leverage resources and investments available at national level and increase their quality and effectiveness.

This, in practice, is achieved by integrating available resources (instrumental as well as human) as contributions "in kind" to CERIC, and opening them to international use and excellence-driven competition. This is expected to generate further synergic use of investments and resources at national, regional and EU level. National and local governments will have the opportunity to further strengthen this process by an appropriate use of Structural Funds, which are available in most participating Countries, effectively responding to the needs of their coordination and synergy with other EU and national resources. Investments in CERIC may also be coordinated with those in other initiatives in areas close to the facilities (e.g. industry clusters, technology parks, spin-offs, etc.) to increase their "absorptive capacity" and transform more effectively science-driven results into innovation and economic opportunities.

The initial main instrumental and human resources belong to the Partner Facilities, and are "conferred" in terms of availability and use to CERIC, allowing the development of services for external users. This scheme has been (and is) extensively used very successfully in several University Consortia[3]

The assets and operation of CERIC will therefore be initially based on in kind contributions (in the form of operating and/or capital contributions) by the Parties. Financial contributions for CERIC ordinary activities can exceptionally be considered. In such cases they may be limited by unilateral declarations by the Parties. All in kind contributions, which shall include access time to instruments, secondment of personnel, and any other type of resource agreed by the Parties and/or their Partner Facilities, will be evaluated and accounted for in order to credit their value as "in kind contributions to the CERIC" based on an accounting system defined by the General Assembly (and verified by external auditors). The General Assembly will also define the general rules for the acceptance and use of in kind and/or financial contributions by the Parties, Observers and/or other public or private entities for specific projects of interest of CERIC.

The proposed initial Partner Facilities were evaluated by an International Committee of independent experts[4]. The Committee produced a first report on the quality and readiness to contribute to CERIC of proposed Partner Facilities[5].

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[3]Some of these Consortia (in particular INFM and INSTM in Italy) have reached the capability to build or participate in the operation of national facilities. This is the case of Elettra, which has been largely built with the support of INFM. In this well tested approach, time availability of equipment and personnel of different Universities is made available to a Consortium (a legal and independent entity) and jointly used to reach critical mass allowing to participate, e.g. in EU projects, and then re-investing the proceeds into "common assets" of the Consortium

High-level independent evaluation is a key instrument to ensure added value to investments and to monitor the quality and capability to attract excellent researchers with a global outreach. Periodic evaluations will be, in the future, performed by the ISTAC, which may suggest, if necessary, initiatives to upgrade and improve, or, in case of non-compliance, the dismissal of a Partner Facility. Evaluations will deal with the technical and instrumentation aspects and - equally important - with the quality and excellence of the support staff and management, thus providing a continuous drive to reach the best world benchmarks.

The success of CERIC will be measured also by its capability to attract financial grants, supports, contributions based on its research and development activities, in particular from EU funded programs and/or from the Observers or other international funding entities. This income will allow reinvesting in upgrading facilities and services offered to the scientific communities, and to build a core of centrally owned resources.

Other structuring activities can be planned with resources expected from limited economic activities (e.g. joint development of commercial services), according with the principles given by the EU Regulation (EC) No. 723/2009. The development of specific activities or projects can be pursued by the use of project-finance based also on loans, if approved by the General Assembly (e.g. from the EIB).CERIC is also entitled to accept grants, special contributions, gifts, donations and other payments from any natural person or legal entity, e.g., charities or foundations.

4. Access to CERIC

The services of CERIC for external scientific users applying to access, free of charge, the analysis and synthesis facilities for research will be supported by a single entry point and evaluation system. The single entry point will also handle applications by industrial users and the information on the various other aspects related and relevant for CERIC activities, e.g., training and employment opportunities, technology transfer activities, general and specific information for the public, etc.

Each Partner Facility will ensure the direct availability of instrumental time and support personnel, as required for the integrated access for research. Partner Facilities will also act as "Reference Point" at national/regional level, providing support to develop the capabilities of the diverse scientific communities operating in their areas, and training them to access both the services of CERIC and other research infrastructures and projects of international level.

The capabilities of the Partner Facilities are broader than those which will be initially contributed to CERIC in terms of access to instruments and services: an interplay is expected between the development of integrated services required by new external users and the further integration of different techniques; this will expand the extent of the integration. Unexpected directions with new types of users and their requirements are quite common when novel instrumental capabilities become available. The amount of instrument-time initially available at each partner facility will be defined after the first "Pilot Call for CERIC Proposals", expected in Autumn 2012. Based on the development of the user community and with the advice of I-EvCo, the available time for each partner facility will be adjusted.

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[4] This Committee is the International Evaluation Committee (EvCo), which has been set-up by the Working Group to act in the present preparatory phase, evaluating the proposals from the Partners. Its activities anticipate those of the ISTAC, which will be set-up after the start of CERIC. The Terms of Reference and composition of the EvCo are in Annex 2

[5] Annex 3: "Report of the International Evaluation Committee (I-EvCo) to the CERIC working group"

In Annex 1, each of the Partner Facilities proposed by the Parties briefly describes its instruments. Those whose access will be contributed to CERIC to ensure a first set of services, at the present stage of evolution, are listed. All other instruments can be made available in response to specific requirements.

The identification of a first set of services has been developed in a meeting of the Directors of the proposed Partner Facilities, as an anticipation of the Board of Directors of CERIC. They have taken into account the requirements of users, based on their previous experience in multi-technique research, and readily agreed an initial proposal, which could allow a first call to users before the end of 2012, and assess their potential response. This offers integrated access for Structural Biology (to the NMR, SAXS, SANS, X-Ray/diffraction, and TEM techniques) and for Solid State Materials-Nanosciences and Nanotechnologies (to the SAXS, NMR, Neutron, TEM, MSB, SPL and SR techniques). This proposal will be evaluated by the international Evaluation Committee (EvCo), which may suggest improvements and/or modifications.

The outreach to new users will also be facilitated by the collaborations existing between CERIC and several initiatives and Institutions involved during the preparatory phase, e.g., the S&T activities of the Central European Initiative (CEI), the International Research Institutions operating in Trieste (ICTP, ICS, ICGEB), National Laboratories, Academies and Universities in the Central/East EU Area, the IAEA etc. This also ensures that the CERIC visibility will go far beyond the regional impact and will have a European and Global outreach.

Over 1500 users from over 50 Countries are already applying, each year, to some of the perspective CERIC Partner Facilities. Several of these facilities are already operating in Partnership, offering integrated services both in their laboratories and in “outstations” connected to beamlines at the synchrotron source in Trieste. This specific integrated service has been particularly attractive for new users in the Central EU area, and has served hundreds of researchers every year, from Europe and outside.

CERIC will further develop this capability, integrating the facilities of the Partners, and developing easy and effective access for external users. “Remote access” methodologies (e.g., for biocrystallography) will be also pursued, building on existing experience. Data elaboration and conservation, as well as access to data, will also be pursued seeking possible improvements in expanding and integrating the corresponding methods over the network of Partner Facilities.

The commonly used procedure for the users access in synchrotron and neutron facilities is based on two international calls per year followed by an evaluation by independent international panels operating in the different areas of research, using web-based methodologies. The panels are in charge to submit the proposals to at least two expert external referees, collect the evaluations, solve possible conflicting judgements either directly or using a third referee, and develop a ranking based on the votes given by the referees for the evaluation criteria. This ranking determines the allocation of access to instruments.

In CERIC this procedure will evolve to handle the systematic integrated use of the multiple sites and facilities. The access to the facilities will be managed by a common web platform, through which the users can access all technical specifications and relevant examples of integrated use of the facilities, and apply accordingly, asking for technical suggestions if needed.

The integration between different access models and panels, together with the possible need to add a further layer of expertise, will be discussed in depth by the Board of Directors and solutions will be proposed to the Assembly and the ISTAC.

The following possible initial working scheme will be developed, based on the amount of time for each instrument that will be available in the framework of CERIC. Users will apply for access to the selected instrumentation (or set of selected scientific instruments) through a single web portal. After a technical feasibility check performed under the responsibility of the Board of Directors, proposals are sent to the CERIC review panel, which is in charge of evaluating their scientific level within the scope of CERIC. In this way, users have direct access to CERIC independently of the individual access to the other parts of the Partner Facilities, and a specific evaluation process is created. This approach ensures user friendliness (by using a single entry point and a single review panel) as well as the scientific quality and the best possible use of the potentialities offered by CERIC, since the review panel will explicitly judge the need of a multi-technique approach. Proposals requesting only one technique could be redirected to the corresponding individual facility.

The treatment of possible complaints, conflicts of interest etc. has been well developed for previous cases of external access to individual facilities and best practices will be employed also in the context of CERIC.

It is expected that in several cases new users, or users of new combinations of different techniques, will receive "training" access and/or "coaching" by the in-house technicians and researchers to jointly lead to improved user services and advances in the instrumentation.

In terms of human resources available for the support of the users, the overall number of scientists (e.g. beamline scientists in synchrotron and neutron centres), technicians and administrative personnel operating in the Partner Facilities exceeds 300. While it is too early to define how many FTE (Full Time Equivalent) of this personnel will be dedicated to the operation of CERIC, it can be reasonably expected that they will be able to ensure the support to the new users. Appropriate training of this staff to collaborate between different facilities and support integrated access will be one of the major and critical aspects in the operation of CERIC.

The above detailed description of the possible methods of access and review of proposals for the free open access to the CERIC facilities is justified by the fact that this is the basic strategic element, agreed by the Parties, to ensure the capability to attract the best research proposals at world level. Furthermore, it will serve as a benchmarking mechanism for the "local" researchers, who will be required to go through the same evaluation process to be admitted as users. This benchmarking mechanism will stimulate a process of competition in an international environment, which (as it has been observed and exploited in other cases) will provide growth to excellence well beyond the direct users, reaching out to the scientific, educational and industrial environment within a wide region.

The access for industries and/or other proprietary requirements will consider both the use of the facilities and Technology Transfer activities. CERIC will ensure and support an active integrated network of the existing Technology Transfer offices operating in the Partner Facilities, and the appropriate training and sharing of know-how to maximize their overall capabilities. This will provide a coordinated access for industries both to the facilities and to cutting edge technology and knowledge, as well as expertise and technical and scientific support to enable the successful exploitation of this knowledge.

One specific advantage of the CERIC distributed nature will be to develop joint procurement and pre-procurement policies to co-develop products and instrumentation together with industry. This may enhance the integration of industrial markets and help to develop new advanced products on a globally competitive basis.

Access to technology transfer activities will also support proprietary R&D projects, such as new and innovative processes, technology, analytical services, development of scientific instruments and special components as well as the access to laboratories based on the needs and initiatives of industry.

5. Contribution to the mobility of knowledge and/or research within the ERA

The setting-up of CERIC by integrating several different facilities into a single distributed infrastructure opens a great opportunity to enhance the circulation of human resources, ideas and innovations with the driving force based on the common scope to be relevant and attractive at the international level.

In the previous paragraph dealing with the Access, a number of aspects relating to the mobility of knowledge between different environments and within the ERA have been addressed. A large part of the mobility of knowledge and know-how "walks with the legs of people" and therefore the mobility of researchers, technicians and administrators must be a specific focus of CERIC.

The mobility of researchers will be further developed by strengthening the existing exchanges and by training a new generation of junior researchers which will "feel at home" in several different facilities. The integration in CERIC will enhance the scientific value of the available facilities and the effectiveness for the users, and also bring together scientists and technicians from different facilities developing and using diverse analytical tools. This will trigger the development and the transfer of novel techniques and opportunities for users, as well as new scientific instruments and products.

To contribute to the mobility of know-how also at managerial and administrative level, CERIC administrative, managerial and support functions shall be, as much as possible, "delocalized" and distributed between the Partners. This will involve the administrative and technical support staff into an effective international mode of operation, supported by appropriate use of ICT technologies and training of personnel. Such a strategy will allow all Partner Facilities to be equally involved in, and acquire, the competence in the various advanced management aspects.

The training of personnel, will, in particular, concern the day-to-day administration and management of the complex environment created by the distributed nature of CERIC, the accounting of financial and in kind contributions, the users access, the internal and external communication, IP protection and valorization, technology transfer and the relationship with industry, Partners' personnel mobility, the filing and recording diverse types of documentation, data processing and storage, the ICT platforms, the communication between Partners and with external users, development of specific rules and best practices, etc.

One important aspect will be the development of appropriate data to assess and measure both the scientific impact of CERIC and its socioeconomic returns (direct and indirect). From this point of view, the use and further development of "social accountability" schemes will be important to share best practices on a wider scale, e.g., to measure environmental impacts, appropriate energy management and use, etc.

The statute of CERIC allows to directly hire personnel for specific joint activities, but only with fixed term contracts. This aims at ensuring flexibility, mobility, and a high level of quality, as it has been demonstrated by the approach implemented by the EMBL in Europe. This has demonstrated the possibility to train a highly mobile research workforce, which has then consistently moved between research and industry at multinational levels.

6. Contribution to the dissemination and optimisation of the results of activities in Community research, technological development and demonstration

The support to economic, educational/training activities, thus generating socioeconomic returns, is a critical role of Research Infrastructures in the European Research Area. The specific construction of CERIC as a distributed infrastructure, with Partner Facilities having the task of regional reference and outreach, creates the opportunity of a major impact. Their outreach and dissemination activities will encompass all aspects, from education to technology and technical training, which can involve the various stakeholders at local, national and EU level.

While the direct results of the research activities by external users will be published in the open literature, the technological, organizational and educational improvements driven by the research competition will be made available through several mechanisms. These will be further developed in all facilities by bringing together the expertise and the opportunities of all partners, as well as by building further on collaborations and synergies available in the region.

One of the activities already taking place, both within CERIC and in a larger context (RAMIRI[6] and ERF[7]), is to organize meetings of the people who, in these facilities, are most active in the liaison with industries, and to develop together an integrated approach to dissemination and value-adding activities towards a better economic outcome of the know-how developed for research. In the case of CERIC, a "business" plan will be developed in which some specific quantitative goals will be developed for the interaction with industries, based on an increase of what is already achieved today, to drive an integration and synergy between the single PF's efforts.

One instrument for the dissemination is a communication activity built by integrating the resources of the Partners. It will address the diverse stakeholders, ranging from the scientific communities, to the educational institutions, the policy makers, the industries, the general public and the media, bringing together communication and press officers, as well as specialized science and technology communicators.

Synergies with other initiatives in the Central East European area are being developed, in particular with other Research Infrastructures involving Countries who participate in CERIC, as e.g. ELI (the Extreme Light Infrastructure built by the Czech Republic, Hungary and Romania). These synergies will optimize different efforts in some critical aspects, as, e.g. technology transfer, procurement and pre-procurement procedures, interaction with Universities and Schools. The co-location of some of these facilities will help the efforts in attracting and possibly building industrial clusters. A critical aspect of building new Research Infrastructures using EU structural funds in the region (e.g. ELI, SOLARIS) is their efficient operation and utilisation beyond the investment period. CERIC will be a most helpful model and partner organisation for creating partnership, building up user communities and gaining operation experience for these new facilities.

One important aspect will be the growth of human resources by networking and strengthening the training and educational activities in the competitive and international environment provided by CERIC. Particular care will be devoted to the educational outreach for young people, to make them aware of the impact of research on our society and stimulate their attention towards scientific studies and careers.

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[6]Realising and Managing International Research Infrastructures (RAMIRI), www.ramiri.eu

[7]European Association of National Research Facilities (ERF), www.europeanresearchfacilities.eu

Guided tours and short training programs for school students are already organized by several Partners. Up to 6000 visitors from the general public visit these Partners every year, 60% coming from schools.

The need of co-developing new instruments and methods, the capability to set up joint teams of researchers and technicians, and to train and hire specific personnel for joint activities will also increase the mobility with respect to industry. This has a strong motivation effect on junior staff and students, reaching out to extended communities in the hosting areas, and a strong attractive base in all partner locations.

The CERIC Partner Facilities have an exceptional body of skills and technical expertise, and various experiences of interaction with industry. By working together and expanding the outreach and the dissemination in the region and beyond, this concentration of knowledge will significantly enhance the regional competitiveness and the attraction of further industrial activities. The interaction with procurement industries to provide CERIC partner facilities with the best possible components, equipment, maintenance, helping a continuous upgrade of their products and may attract possible industrial settlements, and/or the generation of spin-off companies[8].

One of the aims of CERIC will be to augment the effectiveness of each Partner Facility as a possible catalyser of Innovation Clusters by attracting other institutions and Industries. This is already taking place in some of the sites of the perspective partner facilities[9]. CERIC will build on and expand this expertise, in collaboration with local and national authorities, helping the development of "smart specialization approaches".

Direct economic activities may be limited for the nature of the CERIC's core activity, but will be very significant in terms of socioeconomic impact on the territories. These activities must be financially self-sustaining and repay the initial investment for the proprietary access, goods and/or services provided to the market, with an appropriate profit margin. They include collaborations with industries, the industrial use of the facilities, transfer of technology and science-driven innovation.

CERIC will consider various types of mechanisms (such as licensing or spin-off creation) and all possible partners (such as spin-offs or existing companies, other public research organizations, investors, or innovation support services or agencies). It will select the most appropriate ones specifically considering the active transfer and exploitation of intellectual property, within a responsible framework of management of IPR and industrial policy, developed also to enhance the above mechanisms, including appropriate pre-procurement and procurement activities.

The know-how resulting from activities in the field of research and development, performed by CERIC for public or industrial research and its exploitation, will be managed through a common IPR policy, adequately handling the appropriate recognition of activities developed either directly or jointly with the private sector, including in particular collaborative research whereby all parties carry out R&D tasks, and contract research where R&D is contracted out by an industrial private company.

[8] The generation of spin-off companies is already ongoing at some of the Partner Facilities: the cross fertilization between the different Partners and techniques involved in CERIC will be a further motor of this process. As an example, spin-off companies have been started in the Countries developing instruments in close collaboration with BNC in Budapest and with Elettra in Trieste.

[9] Activities of this kind are ongoing in the largest Partner Facilities, the results require a long term perspective and tend to become visible after several years, as in the case of the AREA Science Park, grown after the construction of Elettra and now hosting over 60 industries and over 10 national and international institutions.

Annex 1: Brief description of the initial offer to users and of the Partner Facilities

Brief description of the initial offer to users and of the Partner Facilities

Austria, the Czech Republic, Italy, Hungary, Romania and Slovenia each proposed one Facility, already operational and potentially complementary, to become Partner Facility to C-ERIC. As already explained, the International Evaluation Committee (EvCo)[1] provided a first report; this evaluation procedure will be refined by August 2012. The remaining Parties will propose other facilities during the start-up period.

The facilities proposed so far are described in detail in this Appendix. Without bypassing the evaluation of the EvCo which, in any case, is expected to suggest possible improvements and modifications to the starting programs, it is reasonably probable that, by their present technical qualifications and results in attracting external users, as well as for their previous strong collaborations, these will be considered very good candidates to form the initial core of C-ERIC.

Not all the instrumental capabilities of each facility will be initially proposed as a part of the integrated offer to external users. The novelty of the approach requires a step-by-step development, starting from the most evident users needs and possibly aiming at research problems that already required the use of multiple techniques. This approach will thereafter advance on the basis of requirements expressed by users and pursue further integration.

In each presentation, the Facility has included its view on the added value of being involved in C-ERIC and in some cases (as, e.g. in the Hungarian BNC) specific examples of problems that have been solved by multitechnique approaches.

The type of instruments and amount of time initially made available to C-ERIC is being defined, also on the basis of the positive criticism and advice by the EvCo, by the (interim) Board of Directors composed by the Directors of the Facilities described in this Appendix.

A first meeting was held with a very positive discussion and led to the agreement to indicate the fields of Structural Biology and of Solid State Materials, nanoscience and nanotechnologies as the very first to be addressed. Other fields for which previous experience indicates the need of multitechnique approaches are Cultural Heritage, Environment and Materials for Energy.

Based on the discussions held up to now, the candidate techniques for integrated offer to users are the following (described more in detail in the presentations of the Partner Facilities):

- Life Sciences-Structural Biology:
    - NMR (Slovenia); SAXS (Austria); SANS (Hungary); X-Ray diffraction (Italy); TEM (Romania)
- Solid state materials:
    - SAXS (Austria); NMR (Slovenia); Neutrons (Hungary); TEM (Romania); Photoemission (Czech Republic); SR (Italy)

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[1] See note 4 in the main text

Presentation of the C-ERIC proposed Partner Facility:
Austrian SAXS beamline @ ELETTRA/IBN-Graz

The partner facility will be based on the existing outstation of the Institute of Biophysics and Nanosystems Research (IBN), Austrian Academy of Sciences at the synchrotron ELETTRA and on the home institute as national Austrian entry point. The outstation consists of the Austrian Small Angle Scattering (SAXS) beamline http://www.ibn.oeaw.ac.at/beamline/ , the chemical laboratory of the SAXS beamline. The outstation has also a specific access to the deep X-ray lithography beamline (DXRL) of Elettra. The beamtime available for the outstation is 2500 h per year (SAXS) and of 1250 h per year (DXRL). The Austrian SAXS beamline as well as the chemical laboratory are owned by the Austrian Academy of Sciences and are operated in partnership with Synchrotron Trieste.. Both facilities (SAXS and DXRL) have an excellent record in terms of scientific output and international recognition in the field of biology till materials sciences. With their state-of-the-art instrumentation and expertise the partner facility will contribute to and complement the proposed ERIC structure in the respective fields.

The Austrian C-ERIC entry point

The **Austrian Academy of Sciences (Österreichische Akademie der Wissenschaften, OEAW)** is the largest public non university academic research organization in Austria in order to conduct an extensive research program ranging from social till natural sciences. More than 1100 employees are working currently at the Austrian Academy of Sciences.

As part of the OEAW the **Institute of Biophysics and Nanosystems Research (IBN)** (http://www.ibn.oeaw.ac.at), is a research institute of the Austrian Academy of Sciences with a staff of more than 30 employees, located in Graz (Austria) and founded as Institute of X-ray Structure Research Center Graz in 1968; currently the research is focused mainly on Biophysics and structural investigations on biological/nano-materials targeted on new antibiotics and drug delivery systems therefore bridging the gap between nanoscale materials and biology. The Institute has profound experience in biomimetic coatings, i.e. for bacterial and eukaryotic membrane mimicking coatings, design of antibacterial peptides, lipidomics based drug design, and nanomedicine i.e. lipid based nanoparticles for diagnosis and therapy. Besides the research an intense activity of design and development of instrumentation and sample environment is carried out.

Quality and the potential of the facility to support excellent science at the cutting edge, and offer a service to external users.

Type and quality of the instrumentation

The home institute The core facilities of the IBN match the highest standard in the filed of scientific laboratories and comprise the X-ray laboratory (line-collimation small- and wide angle X-ray cameras and Hecus S3-MICRO point-focussing SAXS/SWAXS camera), the protein crystallography station, the spectroscopy and the thermodynamics.

The protein crystallography station consists of a Nonius FR591 rotating-anode X-ray generator with Osmic MaxFlux optical system and Mar300 imaging plate detector, in combination with an Oxford Cryosystem. Data evaluation, structure determination and molecular modelling are performed on either UNIX workstations or LINUX PCs using latest, standard software packages. Crystallisation robot (Oryx Robot, Douglas Instruments, UK) for precise and large scale throughput screening of crystallisation conditions. The Zetasizer 3000 HAS (Malvern Instruments, Ltd, Worcestershire, UK) allows to measure particle sizes in the range of 5 nm to 5µm and the zeta potential of aqueous liposomal and lipoprotein dispersions.

The spectroscopy station offers Electron spin resonance spectrometer (EPR), Bruker ECS 106, mainly used to study lipid mobility in membranes and lipid-protein interactions by spin labelling techniques.

Fluorometer (Jobin-Yvon) enables the detection of the intrinsic fluorescence of protein/peptide molecules as well as anisotropy measurements on fluorescence labels selectively incorporated in membranes.

The thermodynamics unit gives access to Thermodynamics Differential scanning microcalorimeters (VP-DSC, Microcal, Northampton, MA, USA) are mainly used to study thermotropic transitions of lipid phases and lipid-peptide interactions. Another application is the study of the unfolding of proteins. DSC is complemented by temperature- and pressure-scanning densitometry (DSA 5000, A. Paar, Graz, Austria). Monolayer trough, custom-designed by MDT-Nanotechnology Corp., Moscow, Russia, equipped with a Wilhelmy balanceas well as a surface potential meter, is used to characterize lipid monolayers at the aqueous-gaseous interface and their interaction with peptide molecules dissolved in the aqueous subphase. This equipment is complemented by a Brewster Angle Microscope (BAM-2, NFT, Göttingen, Germany) on courtesy of the Center of Nanobiotechnology, University of Natural Resources and Applied Life Sciences, Vienna.

Apart from these special facilities, standard laboratories for biochemical, analytical, and crystallization work exist.

The Austrian SAXS beamline at Elettra has been in operation since 1996 in collaboration with the IBN, Austrian Academy of Sciences, Graz, Austria and Sincrotrone Trieste (ST) in Italy. Since then the SAXS beamline is in process of continuous renewal and development.

The high flux SAXS beamline at ELETTRA is mainly intended for time resolved studies of fast structural transitions in the sub-millisecond time region of liquids, surface and gas phase with a design goal of at least 100 nm SAXS-resolution. The multipurpose sample station allows for conducting experiments from physics, chemistry, material sciences, pharmaceutics, and biology. Therefore "technological" fields as health, energy, nano-technology and electronics, nanomaterials, nutrition are served by the beamline.

The photon source is the 57 pole wiggler (exit port 5.2) whose beam is shared with the Macromolecular Crystallography beamline. The wiggler delivers a very intense radiation between 4 and 25 keV with a total photon power of 8 kW of which the SAXS beamline accepts 3 discrete energies, mainly 8 keV, as well as 5.4 and 16 keV. A flat double crystal monochromator and a double focusing toroidal mirror are used as beamline optics. A versatile SAXS experimental station has been set-up with the option to use an additional wide angle X-ray scattering (WAXS)-detector for taking simultaneously diffraction patterns in the range of 0.1 - 0.9 nm. The sample station is mounted moveable onto an optical table for optimizing the sample detector distance with respect to SAXS resolution and sample size. As sample stations available are various heating cells (70 K – 800 K), a high pressure cell (0 - 3000 bar), stopped flow and continuous flow apparatus (70 µs – min), mechanical stretching devices to name just a few. Besides the sample cells available at the beamline the users will have the possibility to install their own specialized sample equipment. A complete presentation and specification of the set-ups is found in the Annual Reports of the Austrian SAXS beamline http://www.ibn.oeaw.ac.at/beamline/publications.html. Moreover various detector systems are available at the beamline, which can be selected specifically to the type and requirements of the experiments. These comprise fast gas-detectors with up to 11 µs time-resolution (Gabriel Type; Bruker, Vantec), high flux 2 D single photon counting detectors (Dectris, 100k), and an image plate (Marresearch, Mar300).

The support laboratory is available for both in-house and external user research. The lab facility includes a wet chemical laboratory with a dedicated area for test and implementation of microfluidics systems including syringe pumps, high pressure flow generators, and an X-ray lab equipped with a SWAXS bench instrument (Hecus X-ray systems).

An important asset is the access to 25% of the DXRL beamtime, which allows the production of high aspect ratio three dimensional structures in materials with quasi perfect side-wall verticality, optical quality roughness and a resolution of about 0.5 µm. These structures can then be used as templates to mass-produce microparts made out of a large variety of metals, alloys or ceramics. It opens a wide variety of potential application in the field of microelectromechanical systems (MEMs), fibre and integrated optics, microfluidic devices and interconnection technology. The main field of research is hard X-ray radiation assisted material synthesis and processing. Here materials with specific properties like porosity, hydrophicity/hydrophilicity, crystallinity, hierarchical architectures have been constructed with a simultaneous bottom-up and top-down assembly process.

Availability of adequate support staff

Currently the team of the AustroSAXS outstation consists of 1 Beamline manager (from Sincrotrone Trieste), on group leader, deputy scientist in charge, 1 beamline scientist and 1 postdoctoral fellow and 1 supporting scientist and 1 technician woring part time for the beamline (from Sincrotrone Trieste). The staff operates the SAXS beamline for 5000 h/year and the DXRL beamline up to 2500 h/year.

At the home institution the research is divided in Membrane Medicine - thematically structured in biomembrane physics, membrane targeted drugs and lipidic nano-formulations – and X-ray nano-analytics – divided into laboratory instrument development and application. In these areas work in total 26 researchers, assistant technicians and administration personal.

Availability of appropriate logistical laboratory environment

The outstation is integrated in the logistical environment of Sincrotrone ELETTRA and has therefore access to the supporting facilities of ELETTRA like electronic, mechanical engineering.

Specific procedures of procurement, storage and handling of consumables have been introduced. Special and hazardous substances are tracked and handled appropriately.

Previous experience in "free open access" operation and/or established policy in "free open access" operation and evaluation mechanism of users impact;

The outstation has 16 years of experience in running as an open access facility financed by the Austrian ministry of science and research.

Every year 70% of total beam time is available to external users i.e. 35% to Austrian and 35% to international. All experiment proposals are evaluated by a **peer review committee** and, when recommended, are scheduled and carried out. Additionally 15% of the beamtime is available for in-house research (and 15% maintenance). Every year about 50 proposals are accepted and carried out. The international research teams come from different countries, particularly from Austria, Italy, Germany, France, Croatia, Czech Republic, and Slovenia. Some of the research teams come from overseas. Most user teams were internationally diverse and involved Austrian scientists.

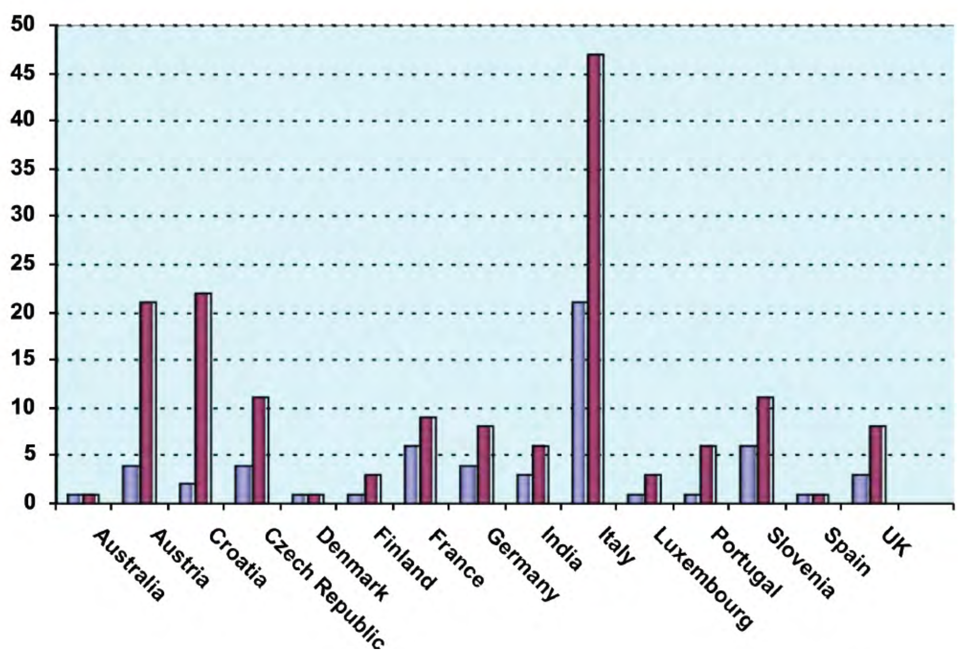

Fig.1 Nationality of the Austrian SAXS beamline users in the year 2010. The number of users (red) and the corresponding number of institutes (blue) are shown for each country.

The national entry point has established links to the Ludwig Bolzmann Institute of lung vasolar research, whose members have access to the methods and expertise offered at the entry point.

Existence of the ICT support infrastructure for data storage, handling and remote access;

All the outstation is fully wired with gigabit Ethernet connections. Every system contributed to the Partner Facility has a dedicated control computer with Internet access. Data storage and backup is being done locally and a secure VPN access is granted to users for remote data recovery. Users can access their data independently from the operational status of the experimental stations. Procedures for remote access of the beamline and the experiments are planned.

Potential complementarities to other proposed Partner Facilities, in the perspective in offering integrated analytical/synthesis capabilities in view of current and future research topics.

The Austrian SAXS beamline together with the national contact point is working on a broad range of materials, from hard/soft condensed matter, to surfaces/interfaces and to biological systems. Therefore with the background at the interface between nano and bio the Austrian partner facility will add to the other partner facilities. In particular the profond experience in the structural characterization with small-angle X-ray scattering (SAXS) as universal structure probe for a wide variety of non-crystalline objects (e.g. macromolecular solutions, detergents, nanocomposites, alloys, synthetic and bio-polymers, biomaterials, organic/inorganic films etc) is an added value to the consortium. Time-resolved synchrotron SAXS yields unique information about the kinetics and dynamics of processes. Scanning SAXS in combination with WAXS (wide angle scattering/diffraction) using sub-micron beams allows one to map the local structure of complex materials. The method also allows for in situ studies including those at extreme conditions. SAXS under grazing incident angles (GISAS), as well as X-ray and neutron reflectometry are extremely powerful tools for the structural characterization of coatings, films and nanoparticles on surfaces. The recent decade has seen a tremendous increase in the user demand of SAXS beamlines at almost all large scale facilities, and this is complemented by an extensive use of home sources in the IBN laboratory.

The combined use of the SANS experiment (of the Hungarian facility) with SAXS is a well established method in small angle scattering by using the unique additional possibilities of labelling by hydrogen/deuterium exchange and also the option of magnetic structure studies with polarized neutrons.

In this respect also solid- and solution-state NMR spectroscopy (Slo) and electron microscopy (Ro) must be seen as additional tools to complete the structural information of the samples.

The target user community is scientists and technologists working on advanced materials (across physics, chemistry and biology) and industry which must be technology-led (e.g. pharmaceutics, electronics, optics, sensors, energy, cosmetic or personal care products and food companies); all are thematic objectives of the European science policy "Horizon 2020".

The "background environment" of the Laboratory/Institution hosting the proposed infrastructure, in view of the development of the best educational, technical training and industrial returns.

Previous experience in European networks

As seen from various EU-projects in the table 1 the outstation is well integrated in the European research scheme. Additionally the outstation participated also in the projects with the principle investigator from the home institution in the last 12 years: "Intas – physics of fluid-to-solid phase transition in lipid membranes", "Marie Curie" EST-Network BIOMEM, "PASERO – Parallel and serial readout systems for (multi)wire proportional synchrotron radiation X-ray detectors."

Previous experience in multiple analytical/synthesis techniques;

As experience the outstation has profound knowledge in preparation and synthesis of biomembranes and mesoporous materials, drug delivery systems based on biomembranes. Furthermore the technological expertise of bottom-up and top-down structuring makes it a highly skilled center of material processing and microstructuring relevant for the development of sensors, photonics and energy applications. All these research topics require the use of multiple/synthesis techniques and have been carried out in very diverse laboratories. Moreover the outstation has participated in EU-projects assembling multiple analytical/synthesis methods like the 7th framework project Nano Foundry and Fine Analysis (NFFA).

Statement on the expected outcome and added value of entering in the C-ERIC.

The outstation will contribute with a world class and highly productive infrastructure to the C-ERIC consortium, which will complement and strengthen the fields with the core competences: biophysics and nanosystems research. On the other hand the outstation will benefit from the existing knowledge of the partner institution and C-Eric links to technology and industry.

General experience in EU and/or international collaborations and contracts;

Table 1: Finished and current national and international projects of the outstation

Finished national and international projects

Name	Year	Proj. Sum*
FWF Arteries	05-08	179.000 €
EU-SAXIER 6th FP	05-09	552.000 €
Suppl. grant SAXIER	05-09	250.000 €
EU-NFFA 7th FP	09-11	255.000 €
Suppl. grant NFFA	09-11	16.500 €
Öster.Austauschdienst	07-08	5.600 €
Öster.Austauschdienst	09-10	6.000 €
		1.264.100 €

Curr. Projects:

Name	Year	Proj. Sum*
Öster.Austauschdienst	11-12	6.000 €

*funding received

Publication record (contents, numbers and quality) of in-house research;

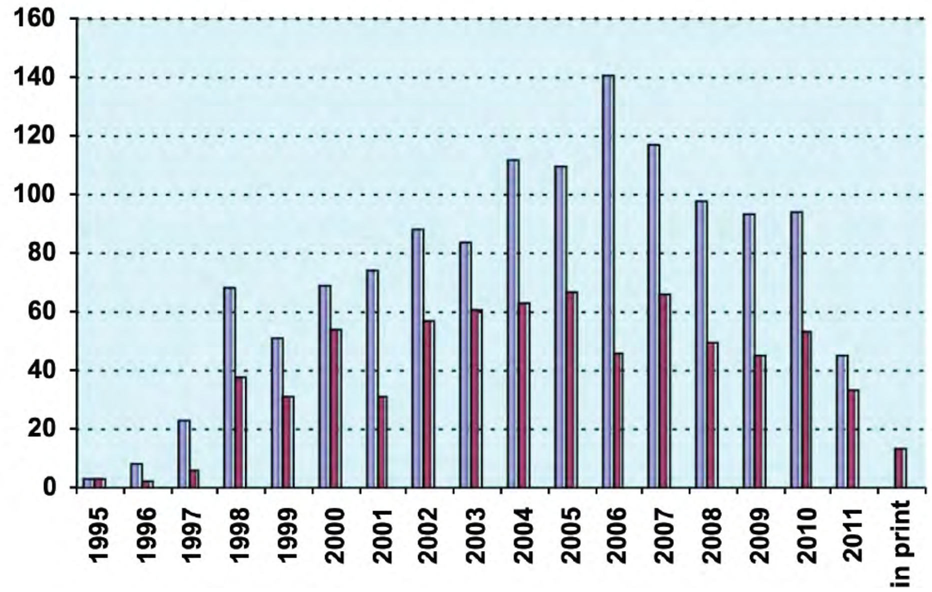

Fig.2 Number of conference contributions (blue) and of refereed paper publications (red) for the years 1995-2010. Also contributions, which have been published until June 2011 as well as those in print at that time are included.

The results of the outstation were published in more than 500 articles in international peer reviewed journals between 1995 and 2011. The graph on the left shows the number of published articles per year as well contributions to conferences since its commencement. The scientific quality of the work conducted at the outstation is high as the respective h-factor is about 35 and the articles obtained with the facility has been cited 6250 times. Specifically, the profiles of the members of the Austrian SAXS beamine are: Heinz Amenitsch (PhD). Senior Scientist, Group leader at the IBN outstation ELETTRA. 20 years experience in Neutron and X-ray scattering, renown expert in small angle scattering, GISAXS on bio- and meso-systems), in-situ SAXS (more than 250 publications in SAXS and related fields). Michael Rappolt (Ass.-Prof. PhD), renown expert in biomembrane structure research with applications to drug delivery and biomedicine. Benedetta Marmiroli (PhD) Scientist at the IBN. 8 years experience in microfluidics and microfabrication: expert in microfluidics, biocrystallization, mesoporous materials, chemical reaction kinetics and DXRL. F. Cacho-Nerin (PhD). Mechanical engineer, expert in computational modelling for microfluidics and in mechanics of biomaterials. Barbara Sartori (MSc) Supporting Scientist, Biologist, (7 years experience in SAXS), mainly interested in biomimetic coatings, SAXS characterization, microfluidics.

A list of other research, educational, industrial activities in easily connected surroundings.

The outstation has established and vivid collaborations to various Austrian Universities. Moreover it has links to the Area-Science Park and University of Trieste. As industrial contacts members of the outstations have been consultants of Hecus X-ray systems.

The unique technological expertise in bottom-up and top-down structuring enables it to act as technological platform for the European science area.

Presentation of the C-ERIC proposed Partner Facility: Charles University in Prague, Czech Republic

The proposed Czech Partner Facility will encompass existing modern research infrastructures at: (1) the Surface Physics Laboratory (SPL) of Charles University in Prague (CUP) and (2) the Materials Science Beamline (MSB) laboratory owned and operated by SPL on behalf of CUP at the Elettra synchrotron in Trieste. The SPL and MSB are established research facilities with a veritable track record in the field of physics and chemistry of surfaces of solids. Backed by further CUP facilities for supplementary bulk material properties measurements, the proposed Partner Facility represents a sound and robust venture to address the challenges of the day in materials science. The Partners will participate in the Facility by contributing their existing infrastructure for preparation and characterization of novel materials on the open access principle, and by developing new instrumentation synergistically within C-ERIC and Partners' legacy academic and industrial networks.

The Czech C-ERIC entry point

The Charles University in Prague will act as an entry point through the Faculty of Mathematics and Physics and through its Department of Surface and Plasma Science.

Charles University in Prague (CUP)

The Charles University in Prague, founded in 1348, is a public university and, as such, an autonomous scientific and educational institution. Of the yearly budget of 300 million EUR about 45% arrives as state educational funding, 29% from competitive research grants and 26% from its own income. The CUP consists of 17 colleges (faculties) with more than 4000 academic and research employees. The university offers 660 disciplines with 300 accredited degree programs, which are attended by 51000 students (6000 of them international) every year, 7000 of them at the doctoral level. This makes the CUP the country's largest university, which steadily ranks in the top 100 universities of Europe and

(1) http://physics.mff.cuni.cz/toISO-8859-2.en/kevf/povrchy/

(2) http://www.elettra.trieste.it/experiments/beamlines/ms/index.html

the only Czech representative in the published list of top 500 European higher education institutions.

Faculty of Mathematics and Physics (FMP) of CUP

The Faculty of Mathematics and Physics, formed in 1952, comprises the School of Mathematics, School of Physics and School of Computer Science. Among them the School of Physics is made of 14 departments and institutes. It employs 343 academic and research staff including 20 full and 92 associate professors, who take care of approximately 2300 students every year. The academic and research personnel take part of more than 200 national and 70 international projects. The yearly grant funds from research funding agencies vary, but averages close to 2.5 million Eur. FMP produces in average more than 1200 scientific papers published in journals with IF per year.

The School of Physics steadily produces about 70% of scientific publications output of FMP with over 700 articles in peer-review journals in 2011. The scientific activity of the School of Physics covers (and is the only school in the Czech Republic to cover) the full range of modern physics. Disciplines with a long tradition, such as physical electronics and vacuum physics, astronomy, meteorology and geophysics are cultivated. The experimental activities are supported by applied physics research, by well-equipped laboratories (cryogenic laboratory, optical methods laboratory, surface physics laboratory, solid state laboratory, high vacuum and plasma laboratory, low energy accelerator laboratory) and by the School's development and production base (glass and optics workshop, the partner Vakuum Praha company, etc.).

The School of Physics is developing broad collaborations on joint projects with other Czech universities and institutes of the Academy of Sciences of the Czech Republic. Collaborations with scientists from universities and research institutions around the world (currently participating in 57 from 119 CUP agreements to date) are mainly in the form of bilateral agreements but also several European Framework Program projects. The top quality collaboration represents the active participation in the Europe-wide projects such as the LHC accelerator at CERN.

The instrumentation brought into C-ERIC

Type and quality of the instrumentation

The Surface Physics Laboratory (SPL) is located in the Troja campus of the Faculty of Mathematics and Physics (FMP) of CUP. The SPL brings into the Partner Facility **four complete systems** for preparation and analysis of materials surfaces, as well as the support from several other instruments including a commercial FIB system and SPL's **own computational cluster**. Our experimental systems each include a number of complementary techniques of surface physics, but they have been dubbed after the prevailing kind of experiments as the **ESCA**, the **STM,** the **DLEED** and the **SIMS**. The **Cluster** is used for *ab initio* DFT(+U) and dynamical LEED theory calculations. All of the experimental systems can be accessed either standalone or as facilities for preliminary specimen characterization and surface control recipe refinement for synchrotron experiments at the Materials Science Beamline (MSB).

The following SPL equipment will be given to C-ERIC disposal:

The **ESCA**, a dedicated system for surface chemical analysis, is equipped with a large Specs™ Phoibos 150 9-channel hemispherical energy analyzer and has been customized for several photoemission spectroscopies (XPS, XPD, UPS and AR-UPS), the ion scattering spectroscopy (ISS, LEIS) and electron diffraction (LEED). It is fully equipped for surface cleaning with ion beams, for thin film deposition by molecular beam epitaxy (MBE) in the main chamber and by RF-magnetron sputtering in a preparation chamber. The system is regularly upgraded.

The **STM** combines atomic-level resolution scanning tunneling microscopy with tunneling spectroscopy (STS) at room and low temperature. Sample heating and cooling (100 – 1500 K), Ar^+ beam cleaning and MBE thin film deposition are implemented for in-situ surface preparation. The experiments are closely followed with *ab initio* calculations of surface electronic structure now done locally at the SPL Cluster. In combination with an integrated thermal desorption spectrometry (TDS) the STM system allows for mapping of the sensory and catalytic properties of materials with structural changes that may occur in the surfaces during their chemical function.

Central European Research Infrastructure Consortium (CERIC)

(www.ceric-eric.eu)

Technical and scientific description

of the distributed research infrastructure

that CERIC will establish and operate

Abstract

Due to the historical events of past century, Centre East European Countries have had fewer opportunities to invest in large research infrastructures and develop them at pan-European dimension.

CERIC (the Central European Research Infrastructure Consortium) aims at contributing to a speedy and cost-effective catch-up of this Region in the field of analysis and synthesis for advanced materials and life sciences with a Research Infrastructure of pan-European quality and relevance. This initiative is open to other Countries capable and willing to contribute to the common goals.

CERIC builds on existing investments in high quality, complementary, regional and national facilities, and its added EU value is achieved by integrating and upgrading them into a unique EU-level distributed infrastructure. This approach is made possible by building on the experience, mutual understanding and trust, previously developed in the long-time integrated operation of several of these infrastructures, and on the collaborations between different Institutions and Countries in the Region.

The Governments of Austria, Croatia, the Czech Republic, Hungary, Italy, Poland, Romania, Serbia and Slovenia have agreed to set-up CERIC. They contribute "in kind", by making available the access and use of existing and new planned facilities and resources, to be integrated into a common research infrastructure capable of offering high-quality Analysis and Synthesis services for research. This access will be open and free of charge for users selected by peer review only, not only from the Region but from anywhere in the world.

The availability of a Research Infrastructure offering a single, coordinated access to different probes and techniques for research in the field of Advanced Materials and Biomaterials responds to a growing requirement at international level, and CERIC will be unique at European and world level for the range and quality of offered techniques.

CERIC will have a single Governance empowered to make the facilities available as an integrated and coherent service to external users, while improving the services offered, to attract and host researchers at global level. The aim of this "open-access integrated operation" is to increase the return of national investments by building a competitive environment for research, education and industry in a coherent and ERA oriented way. CERIC will be able to directly acquire, in a competitive way, resources in the international environment, which will be invested in the upgrade of facilities and services.

Contents

1. Introduction

The proposal of establishing CERIC as a distributed Research Infrastructure, as defined by the European Strategy Forum for Research Infrastructures (ESFRI) within the framework of Pan-EU and of Regional Facilities, was inspired by the discussions and indications developed within ESFRI, in particular in its Regional Working Group, and at various levels, such as in the ECRI Conferences and the Competitiveness Council. It has taken its specific form in the meetings of the Research Ministers of the Centre-East EU and in the meetings of the Salzburg Group and of the Central European Initiative. The Governments that have formally agreed to develop this idea by setting-up a specific Working Group[1] are: Austria, Croatia, the Czech republic, Hungary, Italy, Poland, Romania, Serbia and Slovenia. The CERIC proposal is the outcome of this preparatory phase.

As agreed by the founding Governments (the Parties) CERIC has two main missions:

- to provide research in materials and life sciences with a unique multidisciplinary Research Infrastructure (RI) of Pan-EU and international relevance, operating in the context of the European Research Area.
- to help the catch-up process of the scientific communities in the area, involving them in setting-up and operating this Pan-EU Research Infrastructure, and thus acquiring the capability and training to compete at international level both in terms of research quality and of generating socioeconomic returns.

CERIC includes one Partner Facility (PF) for each participating Country, and its EU added value is achieved by integrating and upgrading them to offer a unique capability to international users as a single "service facility". The PFs are already operational or planned, and their joint operation and access will increase their value and outreach at international level. PFs are proposed by each Country and accepted after international evaluation. Each PF will also have the task to act as a reference for the nearby Region and to connect with the national and regional research centres. Evaluations of each PF and of the central services of CERIC will be performed regularly to ensure quality and effectiveness. The first set of PFs proposed by the Parties is briefly presented in Annex 1, with more details available in their web-sites.

[1] The Working Group has been set-up in February 2011 in Wien, and has worked on the basis of a MOU signed in Bregenz in June 2011 in connection to the "Salzburg Group" meeting and in Trieste in October 2011 in connection to the CEI meeting of Research Ministers.

CERIC's scientific services will be planned with reference to the quality criteria for Pan-EU RIs developed by ESFRI.

The CERIC distributed infrastructure will be a single legal Entity, offering:

- a common, web-operated access point describing and offering the available integrated services;
- a common entry point for users proposals and a common evaluation system to select them and allocate access time to multiple instrumental facilities;
- free and open access to these facilities based on quality selection only;
- support and logistic services as required;

Its Governance will consist of:

- a General Assembly developing a common strategy and defining implementation plans for the integrated facility;
- a Board of Directors in charge of the joint integrated operation of the facilities and of increasing the outreach and use of its scientific and technical capabilities both for Science and for Society.
- an International Scientific and Technical Advisory Committee (ISTAC) to monitor the quality and strategic coherence of the CERIC activities and planning, advising the General Assembly and the Board of Directors.

The General Assembly is composed by the Parties that can appoint, as Representing Entities, the Institutions owning the facilities. The Board of Directors is composed by the Directors of the Partner Facilities who, by statute, must have the power to direct the facilities needed for the operation of CERIC. The Statute of CERIC requires that the Assembly and the Board of Directors take into account the advice and the scientific evaluations by the ISTAC.

The founding Parties of CERIC are Central-East European Area Countries and Regions[2]. This initial geographic focus is due to a long tradition of collaboration and trust between them, and to their will to improve the competitivity of the area. However, CERIC is open to other partners that are willing and capable to contribute to the common effort. Prospective Parties, (e.g. Countries still developing appropriate partner facilities) and Countries involved within CERIC in joint projects with specific scope and time scale may become Observers in CERIC.

CERIC will build on the scientific quality of the Institutions operating in the Central-Eastern EU area. This will contribute to speed-up the efforts to reach the same level of capabilities already existing in other parts of the EU, ensuring the growth of excellence for a wider scientific community, including the development of the science and science-driven technology basis of the European Research Area.

2. Necessity of CERIC for the carrying-out of European research programmes and projects

CERIC responds to two main needs for European Research: maintaining and strengthening cutting edge competitivity in a relevant scientific field, and speeding up the involvement of all its human resources in advanced, competitive research and innovation.

CERIC will operate in the wide research area of nanoscale analysis and synthesis for Materials Sciences, including areas linked to Biomaterials and Structural Biology. This overall scientific area is a basic

[2] The involvement of the Italian government has been particularly supported by the Regional Government of the Trieste area, which has a strong Centre-East EU orientation.

component and a strategic contributor to European competitivity, being directly connected to the support of product quality and innovation in manufacturing, biomedical, chemical and other industries.

Analytical capabilities made available by the PFs span lateral resolution at the nanoscale or even at the atomic level, based on complementary probes (electromagnetic waves, neutrons and electrons) while synthesis techniques cover the range from physico-chemical to biochemical methods. Time-resolved techniques will also reach time definitions comparable to atomic and molecular processes, in the femtosecond domain.

CERIC focuses on the increasing necessity, by Materials and Life Sciences Research, to offer the capability to analyze and characterize the same material with several complementary probes and techniques, and also to manipulate different aspects in its synthesis and preparation. The competitive advantage of CERIC will be the capability to offer, in an integrated way and at international level, access to top-quality probes and to a large inventory of different characterization and preparation techniques.

So far, users were required to apply at different laboratories and undergo different uncoordinated peer review evaluations to be able to perform a single complete study. CERIC will provide coordinated and specifically designed access to the needed set of complementary methods and instruments. Such a research infrastructure is not available anywhere else in Europe and, as far as we know, in the world. Although there are examples of specific sites offering access to some of these methods, these are independent, not coordinated laboratories (such as the ILL and ESRF in Grenoble or ISIS and DIAMOND in Oxfordshire). CERIC will focus specifically on scientific problems in which a multi-technique approach is required and, when properly implemented, gives a competitive advantage.

By involving research centres in nine Countries into an integrated and world competitive effort, CERIC will also involve a large number of researchers and technicians in a more competitive environment, and will help local institutions to develop the best approach to attract and use the outcomes of science-driven innovation and education.

Analytical facilities for Materials Sciences capable of nano (atomic) level definition are based on the use of probes able to sense single atoms/electrons/nuclei: these probes are *Electromagnetic waves* from radio to ultra-short wavelengths in the hard X-Rays region (with techniques ranging from NMR and photon spectroscopies to microscopies), *Electron*s (in high definition transmission, diffraction or reflection microscopies), or *Neutrons* (in scattering and or transmission spectroscopies). Other more specialized probes (*protons, muons, positrons*, etc.) are used in particular cases but are not planned at present within CERIC. The equipments used in the analytical facilities consist typically of an advanced-quality source of the appropriate probe (from high RF frequency/high magnetic field NMR to high photon brilliance synchrotrons and free electron lasers, and to high flux-slow neutrons) connected to measuring equipment which allows to fully exploit the quality of the source and to collect the relevant data produced by the interaction between the probes and the materials under study.

Synthesis facilities for material preparation at the atomic level of control are a wide class, ranging from physico-chemical to chemical assembly (e.g. from vacuum deposition to sputtering, laser ablation, molecular epitaxy and chemical structuring) to biological selection and assembly (e.g. PCR production of proteins). These are typically referred to as “sample preparation facilities”, and are a very important asset when properly connected to analytical facilities, e.g., bio-crystallography laboratories including the growth of protein crystals.

The prospective Partner facilities of CERIC together provide most of the techniques listed above, including a “theoretical support group”, to develop appropriate theoretical and computational instruments.

New facilities are being built and/or planned in Poland, Serbia and Croatia, and upgrades are planned for the already operational facilities. CERIC will help to develop a strong coordination between these new investments and obtain a more effective and competitive result.

The facilities offered are the best ones selected in terms of quality. No *a priori* selection of the types of infrastructures and of the topics to be proposed by the perspective users was done. This is based on previous experience in planning and designing multidisciplinary analytical facilities (like synchrotrons and neutron facilities) which has proven that in most cases the requirements and the science fields proposed by new users exceed by far the advance planning and imagination by facility builders. Indeed most of the users of ESRF in Grenoble or of Elettra in Trieste were not anticipated during the design and construction phases, albeit the design studies involved all major experts in the subject. The new CERIC distributed facility starts with the ambition of increasing the value and the use of a far wider, and already existing, high quality instrumental endowment.

Excluding the possibility of new and unexpected users coming forward would risk to decrease the potential of a positive impact.

We plan a more empirical approach, following closely the responses of the users, while investing in the training of a younger generation of researchers who will have open access to these capabilities and will have a fresh outlook in combining the available techniques while approaching existing and new problems in new ways. For this reason one of the first initiatives of CERIC will be to organize, from the first year, schools and training activities to take place involving the different PFs, to expose present staff and junior people to the variety of instruments and topics already available and to be further developed, with the view of stimulating cross-fertilization and new ideas.

Concentrating on few scientific fields would go counter the experience gained in the previous analytical facilities, and risk to limit the very fertile cross-disciplinary interaction which has been driving the development and improvement of analytical and synthetic techniques in multidisciplinary facilities. The ERA does not necessarily need to be "structured" along present disciplinary divides, but should take stock of the potential of cross-and multi-disciplinary approaches, as required by the need to face the grand challenges.

CERIC builds on a strong foundation: the PFs have already been developing and operating international-level facilities and capabilities, with equipment and staff dedicated to the support of external users, and have achieved extensive response from international user communities, especially in the NMR, synchrotron/free electron laser, and neutron facilities.

Moreover, the integration between the Partner facilities is based on previous successful experience. Several of them have already operated in an integrated way and/or in extensive collaborations. For example the photon beamlines and measuring stations built by Institutions in Austria, the Czech Republic and Slovenia have successfully been operating within the Elettra facility in Trieste as "in kind" participations based on the equipment and personnel of the home institutions. These earlier experiences already produced a growing outreach to the Central EU scientific communities and a strong and increasing response from the scientific users also beyond the specific Countries involved.

The collaboration between different technicians and scientists from the different countries and facilities, who must co-operate in an harmonized way to respond to the requirements of users, and integrate techniques they are not initially familiar with, will train and educate a new generation of scientists and technicians to operate with a problem-solving attitude.

3. Added value in strengthening and structuring of the European Research Area (ERA)

In the past century, the Central European Region has had fewer opportunities than other parts of the world to invest in large research infrastructures of pan-European dimension, and a speedy re-alignment of this Region with the "older" EU Member States is essential for Europe as a whole, to fully exploit its human potential in view of the fast growth of other large Nations (India, China, Russia, etc.).

In the present financial and regulatory circumstances, to launch new initiatives requiring large investments is bound to give results only in the longer term, while a faster and more effective approach can be implemented by improving "national" investments, already existing and/or planned, which, without an international approach and competitive drive, would not have a Pan-EU impact.

The approach adopted by CERIC and supported by the founding Parties is to start a process enhancing the quality and returns of available resources, and obtain results greater than the simple sum of the contributed parts. The main driver will be the opening to international competitive access, to leverage resources and investments available at national level and increase their quality and effectiveness.

This, in practice, is achieved by integrating available resources (instrumental as well as human) as contributions "in kind" to CERIC, and opening them to international use and excellence-driven competition. This is expected to generate further synergic use of investments and resources at national, regional and EU level. National and local governments will have the opportunity to further strengthen this process by an appropriate use of Structural Funds, which are available in most participating Countries, effectively responding to the needs of their coordination and synergy with other EU and national resources. Investments in CERIC may also be coordinated with those in other initiatives in areas close to the facilities (e.g. industry clusters, technology parks, spin-offs, etc.) to increase their "absorptive capacity" and transform more effectively science-driven results into innovation and economic opportunities.

The initial main instrumental and human resources belong to the Partner Facilities, and are "conferred" in terms of availability and use to CERIC, allowing the development of services for external users. This scheme has been (and is) extensively used very successfully in several University Consortia[3]

The assets and operation of CERIC will therefore be initially based on in kind contributions (in the form of operating and/or capital contributions) by the Parties. Financial contributions for CERIC ordinary activities can exceptionally be considered. In such cases they may be limited by unilateral declarations by the Parties. All in kind contributions, which shall include access time to instruments, secondment of personnel, and any other type of resource agreed by the Parties and/or their Partner Facilities, will be evaluated and accounted for in order to credit their value as "in kind contributions to the CERIC" based on an accounting system defined by the General Assembly (and verified by external auditors). The General Assembly will also define the general rules for the acceptance and use of in kind and/or financial contributions by the Parties, Observers and/or other public or private entities for specific projects of interest of CERIC.

The proposed initial Partner Facilities were evaluated by an International Committee of independent experts[4]. The Committee produced a first report on the quality and readiness to contribute to CERIC of proposed Partner Facilities[5].

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[3]Some of these Consortia (in particular INFM and INSTM in Italy) have reached the capability to build or participate in the operation of national facilities. This is the case of Elettra, which has been largely built with the support of INFM. In this well tested approach, time availability of equipment and personnel of different Universities is made available to a Consortium (a legal and independent entity) and jointly used to reach critical mass allowing to participate, e.g. in EU projects, and then re-investing the proceeds into "common assets" of the Consortium

High-level independent evaluation is a key instrument to ensure added value to investments and to monitor the quality and capability to attract excellent researchers with a global outreach. Periodic evaluations will be, in the future, performed by the ISTAC, which may suggest, if necessary, initiatives to upgrade and improve, or, in case of non-compliance, the dismissal of a Partner Facility. Evaluations will deal with the technical and instrumentation aspects and - equally important - with the quality and excellence of the support staff and management, thus providing a continuous drive to reach the best world benchmarks.

The success of CERIC will be measured also by its capability to attract financial grants, supports, contributions based on its research and development activities, in particular from EU funded programs and/or from the Observers or other international funding entities. This income will allow reinvesting in upgrading facilities and services offered to the scientific communities, and to build a core of centrally owned resources.

Other structuring activities can be planned with resources expected from limited economic activities (e.g. joint development of commercial services), according with the principles given by the EU Regulation (EC) No. 723/2009. The development of specific activities or projects can be pursued by the use of project-finance based also on loans, if approved by the General Assembly (e.g. from the EIB).CERIC is also entitled to accept grants, special contributions, gifts, donations and other payments from any natural person or legal entity, e.g., charities or foundations.

4. Access to CERIC

The services of CERIC for external scientific users applying to access, free of charge, the analysis and synthesis facilities for research will be supported by a single entry point and evaluation system. The single entry point will also handle applications by industrial users and the information on the various other aspects related and relevant for CERIC activities, e.g., training and employment opportunities, technology transfer activities, general and specific information for the public, etc.

Each Partner Facility will ensure the direct availability of instrumental time and support personnel, as required for the integrated access for research. Partner Facilities will also act as "Reference Point" at national/regional level, providing support to develop the capabilities of the diverse scientific communities operating in their areas, and training them to access both the services of CERIC and other research infrastructures and projects of international level.

The capabilities of the Partner Facilities are broader than those which will be initially contributed to CERIC in terms of access to instruments and services: an interplay is expected between the development of integrated services required by new external users and the further integration of different techniques; this will expand the extent of the integration. Unexpected directions with new types of users and their requirements are quite common when novel instrumental capabilities become available. The amount of instrument-time initially available at each partner facility will be defined after the first "Pilot Call for CERIC Proposals", expected in Autumn 2012. Based on the development of the user community and with the advice of I-EvCo, the available time for each partner facility will be adjusted.

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[4] This Committee is the International Evaluation Committee (EvCo), which has been set-up by the Working Group to act in the present preparatory phase, evaluating the proposals from the Partners. Its activities anticipate those of the ISTAC, which will be set-up after the start of CERIC. The Terms of Reference and composition of the EvCo are in Annex 2

[5] Annex 3: "Report of the International Evaluation Committee (I-EvCo) to the CERIC working group"

In Annex 1, each of the Partner Facilities proposed by the Parties briefly describes its instruments. Those whose access will be contributed to CERIC to ensure a first set of services, at the present stage of evolution, are listed. All other instruments can be made available in response to specific requirements.

The identification of a first set of services has been developed in a meeting of the Directors of the proposed Partner Facilities, as an anticipation of the Board of Directors of CERIC. They have taken into account the requirements of users, based on their previous experience in multi-technique research, and readily agreed an initial proposal, which could allow a first call to users before the end of 2012, and assess their potential response. This offers integrated access for Structural Biology (to the NMR, SAXS, SANS, X-Ray/diffraction, and TEM techniques) and for Solid State Materials-Nanosciences and Nanotechnologies (to the SAXS, NMR, Neutron, TEM, MSB, SPL and SR techniques). This proposal will be evaluated by the international Evaluation Committee (EvCo), which may suggest improvements and/or modifications.

The outreach to new users will also be facilitated by the collaborations existing between CERIC and several initiatives and Institutions involved during the preparatory phase, e.g., the S&T activities of the Central European Initiative (CEI), the International Research Institutions operating in Trieste (ICTP, ICS, ICGEB), National Laboratories, Academies and Universities in the Central/East EU Area, the IAEA etc. This also ensures that the CERIC visibility will go far beyond the regional impact and will have a European and Global outreach.

Over 1500 users from over 50 Countries are already applying, each year, to some of the perspective CERIC Partner Facilities. Several of these facilities are already operating in Partnership, offering integrated services both in their laboratories and in "outstations" connected to beamlines at the synchrotron source in Trieste. This specific integrated service has been particularly attractive for new users in the Central EU area, and has served hundreds of researchers every year, from Europe and outside.

CERIC will further develop this capability, integrating the facilities of the Partners, and developing easy and effective access for external users. "Remote access" methodologies (e.g., for biocrystallography) will be also pursued, building on existing experience. Data elaboration and conservation, as well as access to data, will also be pursued seeking possible improvements in expanding and integrating the corresponding methods over the network of Partner Facilities.

The commonly used procedure for the users access in synchrotron and neutron facilities is based on two international calls per year followed by an evaluation by independent international panels operating in the different areas of research, using web-based methodologies. The panels are in charge to submit the proposals to at least two expert external referees, collect the evaluations, solve possible conflicting judgements either directly or using a third referee, and develop a ranking based on the votes given by the referees for the evaluation criteria. This ranking determines the allocation of access to instruments.

In CERIC this procedure will evolve to handle the systematic integrated use of the multiple sites and facilities. The access to the facilities will be managed by a common web platform, through which the users can access all technical specifications and relevant examples of integrated use of the facilities, and apply accordingly, asking for technical suggestions if needed.

The integration between different access models and panels, together with the possible need to add a further layer of expertise, will be discussed in depth by the Board of Directors and solutions will be proposed to the Assembly and the ISTAC.

The following possible initial working scheme will be developed, based on the amount of time for each instrument that will be available in the framework of CERIC. Users will apply for access to the selected instrumentation (or set of selected scientific instruments) through a single web portal. After a technical feasibility check performed under the responsibility of the Board of Directors, proposals are sent to the CERIC review panel, which is in charge of evaluating their scientific level within the scope of CERIC. In this way, users have direct access to CERIC independently of the individual access to the other parts of the Partner Facilities, and a specific evaluation process is created. This approach ensures user friendliness (by using a single entry point and a single review panel) as well as the scientific quality and the best possible use of the potentialities offered by CERIC, since the review panel will explicitly judge the need of a multi-technique approach. Proposals requesting only one technique could be redirected to the corresponding individual facility.

The treatment of possible complaints, conflicts of interest etc. has been well developed for previous cases of external access to individual facilities and best practices will be employed also in the context of CERIC.

It is expected that in several cases new users, or users of new combinations of different techniques, will receive "training" access and/or "coaching" by the in-house technicians and researchers to jointly lead to improved user services and advances in the instrumentation.

In terms of human resources available for the support of the users, the overall number of scientists (e.g. beamline scientists in synchrotron and neutron centres), technicians and administrative personnel operating in the Partner Facilities exceeds 300. While it is too early to define how many FTE (Full Time Equivalent) of this personnel will be dedicated to the operation of CERIC, it can be reasonably expected that they will be able to ensure the support to the new users. Appropriate training of this staff to collaborate between different facilities and support integrated access will be one of the major and critical aspects in the operation of CERIC.

The above detailed description of the possible methods of access and review of proposals for the free open access to the CERIC facilities is justified by the fact that this is the basic strategic element, agreed by the Parties, to ensure the capability to attract the best research proposals at world level. Furthermore, it will serve as a benchmarking mechanism for the "local" researchers, who will be required to go through the same evaluation process to be admitted as users. This benchmarking mechanism will stimulate a process of competition in an international environment, which (as it has been observed and exploited in other cases) will provide growth to excellence well beyond the direct users, reaching out to the scientific, educational and industrial environment within a wide region.

The access for industries and/or other proprietary requirements will consider both the use of the facilities and Technology Transfer activities. CERIC will ensure and support an active integrated network of the existing Technology Transfer offices operating in the Partner Facilities, and the appropriate training and sharing of know-how to maximize their overall capabilities. This will provide a coordinated access for industries both to the facilities and to cutting edge technology and knowledge, as well as expertise and technical and scientific support to enable the successful exploitation of this knowledge.

One specific advantage of the CERIC distributed nature will be to develop joint procurement and pre-procurement policies to co-develop products and instrumentation together with industry. This may enhance the integration of industrial markets and help to develop new advanced products on a globally competitive basis.

Access to technology transfer activities will also support proprietary R&D projects, such as new and innovative processes, technology, analytical services, development of scientific instruments and special components as well as the access to laboratories based on the needs and initiatives of industry.

5. Contribution to the mobility of knowledge and/or research within the ERA

The setting-up of CERIC by integrating several different facilities into a single distributed infrastructure opens a great opportunity to enhance the circulation of human resources, ideas and innovations with the driving force based on the common scope to be relevant and attractive at the international level.

In the previous paragraph dealing with the Access, a number of aspects relating to the mobility of knowledge between different environments and within the ERA have been addressed. A large part of the mobility of knowledge and know-how "walks with the legs of people" and therefore the mobility of researchers, technicians and administrators must be a specific focus of CERIC.

The mobility of researchers will be further developed by strengthening the existing exchanges and by training a new generation of junior researchers which will "feel at home" in several different facilities. The integration in CERIC will enhance the scientific value of the available facilities and the effectiveness for the users, and also bring together scientists and technicians from different facilities developing and using diverse analytical tools. This will trigger the development and the transfer of novel techniques and opportunities for users, as well as new scientific instruments and products.

To contribute to the mobility of know-how also at managerial and administrative level, CERIC administrative, managerial and support functions shall be, as much as possible, "delocalized" and distributed between the Partners. This will involve the administrative and technical support staff into an effective international mode of operation, supported by appropriate use of ICT technologies and training of personnel. Such a strategy will allow all Partner Facilities to be equally involved in, and acquire, the competence in the various advanced management aspects.

The training of personnel, will, in particular, concern the day-to-day administration and management of the complex environment created by the distributed nature of CERIC, the accounting of financial and in kind contributions, the users access, the internal and external communication, IP protection and valorization, technology transfer and the relationship with industry, Partners' personnel mobility, the filing and recording diverse types of documentation, data processing and storage, the ICT platforms, the communication between Partners and with external users, development of specific rules and best practices, etc.

One important aspect will be the development of appropriate data to assess and measure both the scientific impact of CERIC and its socioeconomic returns (direct and indirect). From this point of view, the use and further development of "social accountability" schemes will be important to share best practices on a wider scale, e.g., to measure environmental impacts, appropriate energy management and use, etc.

The statute of CERIC allows to directly hire personnel for specific joint activities, but only with fixed term contracts. This aims at ensuring flexibility, mobility, and a high level of quality, as it has been demonstrated by the approach implemented by the EMBL in Europe. This has demonstrated the possibility to train a highly mobile research workforce, which has then consistently moved between research and industry at multinational levels.

6. Contribution to the dissemination and optimisation of the results of activities in Community research, technological development and demonstration

The support to economic, educational/training activities, thus generating socioeconomic returns, is a critical role of Research Infrastructures in the European Research Area. The specific construction of CERIC as a distributed infrastructure, with Partner Facilities having the task of regional reference and outreach, creates the opportunity of a major impact. Their outreach and dissemination activities will encompass all aspects, from education to technology and technical training, which can involve the various stakeholders at local, national and EU level.

While the direct results of the research activities by external users will be published in the open literature, the technological, organizational and educational improvements driven by the research competition will be made available through several mechanisms. These will be further developed in all facilities by bringing together the expertise and the opportunities of all partners, as well as by building further on collaborations and synergies available in the region.

One of the activities already taking place, both within CERIC and in a larger context (RAMIRI[6] and ERF[7]), is to organize meetings of the people who, in these facilities, are most active in the liaison with industries, and to develop together an integrated approach to dissemination and value-adding activities towards a better economic outcome of the know-how developed for research. In the case of CERIC, a "business" plan will be developed in which some specific quantitative goals will be developed for the interaction with industries, based on an increase of what is already achieved today, to drive an integration and synergy between the single PF's efforts.

One instrument for the dissemination is a communication activity built by integrating the resources of the Partners. It will address the diverse stakeholders, ranging from the scientific communities, to the educational institutions, the policy makers, the industries, the general public and the media, bringing together communication and press officers, as well as specialized science and technology communicators.

Synergies with other initiatives in the Central East European area are being developed, in particular with other Research Infrastructures involving Countries who participate in CERIC, as e.g. ELI (the Extreme Light Infrastructure built by the Czech Republic, Hungary and Romania). These synergies will optimize different efforts in some critical aspects, as, e.g. technology transfer, procurement and pre-procurement procedures, interaction with Universities and Schools. The co-location of some of these facilities will help the efforts in attracting and possibly building industrial clusters. A critical aspect of building new Research Infrastructures using EU structural funds in the region (e.g. ELI, SOLARIS) is their efficient operation and utilisation beyond the investment period. CERIC will be a most helpful model and partner organisation for creating partnership, building up user communities and gaining operation experience for these new facilities.

One important aspect will be the growth of human resources by networking and strengthening the training and educational activities in the competitive and international environment provided by CERIC. Particular care will be devoted to the educational outreach for young people, to make them aware of the impact of research on our society and stimulate their attention towards scientific studies and careers.

[6] Realising and Managing International Research Infrastructures (RAMIRI), www.ramiri.eu

[7] European Association of National Research Facilities (ERF), www.europeanresearchfacilities.eu

Guided tours and short training programs for school students are already organized by several Partners. Up to 6000 visitors from the general public visit these Partners every year, 60% coming from schools.

The need of co-developing new instruments and methods, the capability to set up joint teams of researchers and technicians, and to train and hire specific personnel for joint activities will also increase the mobility with respect to industry. This has a strong motivation effect on junior staff and students, reaching out to extended communities in the hosting areas, and a strong attractive base in all partner locations.

The CERIC Partner Facilities have an exceptional body of skills and technical expertise, and various experiences of interaction with industry. By working together and expanding the outreach and the dissemination in the region and beyond, this concentration of knowledge will significantly enhance the regional competitiveness and the attraction of further industrial activities. The interaction with procurement industries to provide CERIC partner facilities with the best possible components, equipment, maintenance, helping a continuous upgrade of their products and may attract possible industrial settlements, and/or the generation of spin-off companies[8].

One of the aims of CERIC will be to augment the effectiveness of each Partner Facility as a possible catalyser of Innovation Clusters by attracting other institutions and Industries. This is already taking place in some of the sites of the perspective partner facilities[9]. CERIC will build on and expand this expertise, in collaboration with local and national authorities, helping the development of "smart specialization approaches".

Direct economic activities may be limited for the nature of the CERIC's core activity, but will be very significant in terms of socioeconomic impact on the territories. These activities must be financially self-sustaining and repay the initial investment for the proprietary access, goods and/or services provided to the market, with an appropriate profit margin. They include collaborations with industries, the industrial use of the facilities, transfer of technology and science-driven innovation.

CERIC will consider various types of mechanisms (such as licensing or spin-off creation) and all possible partners (such as spin-offs or existing companies, other public research organizations, investors, or innovation support services or agencies). It will select the most appropriate ones specifically considering the active transfer and exploitation of intellectual property, within a responsible framework of management of IPR and industrial policy, developed also to enhance the above mechanisms, including appropriate pre-procurement and procurement activities.

The know-how resulting from activities in the field of research and development, performed by CERIC for public or industrial research and its exploitation, will be managed through a common IPR policy, adequately handling the appropriate recognition of activities developed either directly or jointly with the private sector, including in particular collaborative research whereby all parties carry out R&D tasks, and contract research where R&D is contracted out by an industrial private company.

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[8]The generation of spin-off companies is already ongoing at some of the Partner Facilities: the cross fertilization between the different Partners and techniques involved in CERIC will be a further motor of this process. As an example, spin-off companies have been started in the Countries developing instruments in close collaboration with BNC in Budapest and with Elettra in Trieste.

[9]Activities of this kind are ongoing in the largest Partner Facilities, the results require a long term perspective and tend to become visible after several years, as in the case of the AREA Science Park, grown after the construction of Elettra and now hosting over 60 industries and over 10 national and international institutions.

The high-resolution **DLEED** system contains a 4-grid high resolution Specs™ ErLEED 150 and 5-axis manipulator for the dynamical LEED (I-V LEED) measurements of crystal surfaces to reveal the near-surface local structure information. As a complete UHV system with base pressure 2×10^{-9} mbar it is equipped with Ar^+ beam surface cleaning and MBE thin film deposition, while the sample temperature can be controlled in from 120 K to 1500 K. The dynamical LEED theory simulations are realized on the local computational cluster.

The **SIMS** is a standalone commercial UHV instrument by Physical Instruments Inc. for static and dynamical Secondary Ion Mass Spectrometry. This system is suited for chemical depth profile analysis of multilayers and specimens prepared ex situ, or using weakly controlled synthetic processes.

<u>*The following **additional equipment** available at the SPL will be used for supporting the C-ERIC User projects:*</u>

The **FIB** is a high vacuum commercial Tescan Lyra II dual-beam focused ion beam (FIB) lithography instrument with scanning electron microscope (SEM) installed new in 2009. A five-source multi-gas injection system (GIS) is used for thin film deposition and top-down nanostructure growth by beam-induced precursor decay, for which a 2-nm electron beam and a 50-nm Gallium ion beam can be used. The instrument's analytical techniques include electron secondary emission spectroscopy, electron back-scattering spectroscopy and energy dispersion chemical micro-analysis (EDX).

The SPL **computational cluster** consists of two servers each containing 32 processor cores, 32 GB RAM and 4 TB of storage. The communication between the servers is realized by high-speed InfiniBand connection. The cluster is operated under a Linux OS and supports several mathematical and parallelization libraries such as MPI, BLAS, LAPACK or FFTW. The cluster is currently running calculations using a first principles code Quantum ESPRESSO and a LEED calculations package SATLEED.

Standalone RF magnetron sputtering deposition chamber, a Flow microreactor, a Fuel Cell test station, a basic wet process chemistry laboratory, FTIR Reflection Spectroscopy, multimode in-air AFM and MFM, two additional photoemission instruments combining XPS, XPD, (AR-)UPS, AES, LEIS, LEED, Reflection High Energy Electron Diffraction (RHEED) and MBE thin film deposition, a furnace for sample annealing up to 1300°C, spot welders, electronics workshop and an optical microscope.

The Materials Science Beamline (MSB) at Elettra will share its capacity between standard users of Elettra and C-ERIC users on the base of equal beamtime distribution (50 and 50%).

MSB has been running since 2002 in collaboration of the Charles University in Prague (CUP), the Institute of Physics of the Academy of Sciences of the Czech Republic (IPCAS), and the Sincrotrone Trieste (ST) in Italy. The MSB end-station is owned by the SPL and constitutes its most significant and important experimental system. It is a **versatile synchrotron beamline laboratory** suitable for surface physics and material science experiments on materials of interest such as thin film catalysts and organic molecules adsorbed on various substrates. The bending magnet with fast tuning produces photons with energy in the range from 22 to 1000 eV, which provides several photoemission spectroscopy techniques. There are the ultra-violet (UPS) and x-ray (XPS) photoemission spectroscopies with high energy resolution. The tunable excitation energy allows for experiment optimization regarding the photoionization cross section. The excellent energy resolution of ~100 meV also allows for the soft x-ray resonant photoemission (SXRPES) and the near-edge X-ray absorption fine structure (NEXAFS) spectroscopies. The automated sample rotation about two axes then allows for angle-resolved (AR-PES, XPD) photoemission studies.

The MSB is based on a bending magnet radiation source (bending magnet 6.1 at the Elettra storage ring) with a single SX-700 plane grating monochromator. The monochromator, gold-plated focusing mirrors and the apertures (entrance and exit slits) produce a beam with spot size ~100 µm on the sample, while the photon flux is continuously monitored by a fine gold mesh. Photoelectrons from the sample are analyzed by a large 9-channel Specs™ Phoibos 150 hemispherical energy analyzer oriented at a 60° from the beam. Under these conditions the resolving power is above 1000 and the energy resolution better than 100 meV. Samples are mounted in a holder on a manipulator with motorized linear motion along the X, Y and Z axes and azimuthal and polar rotation. The manipulator allows heating and cooling of the sample in a temperature range 110-1200 K. The experimental chamber with base pressure in low 10^{-10} mbar is equipped with a quadrupole mass spectrometer for residual gas analysis, with Ar^+ sputtering, reactive gas lines with precision leak valves and a set of evaporators, all for in-situ preparation of well-defined surfaces of various materials.

A small preparation chamber with base pressure in the 10^{-9} mbar range is available as well for sample treatment with Ar^+ sputtering. There the sample is held on the rod of the magnetic transfer. The preparation chamber has several DN40CF and DN63CF flanges available for users' equipment and the volume is small enough, so that only 30 minutes are needed for sample transfer from air to working vacuum conditions. The MSB laboratory is fully supported by the SPL facilities in Prague for the necessary equipment adjustments, renovation and all ex-situ sample preparation.

Availability of adequate support staff

For experiments in Prague (at SPL and all supporting facilities) the User research teams will be supported by the Surface Physics Laboratory group and other department staff, namely 1 full Professor, 8 Associate and Assistant Professors, 11 Senior Researchers, and a number of SPL department students (currently 36 at PhD and Master level). Employment of a technician/engineer to maintain and operate the UHV systems and the deposition facilities is planned. The MSB support team consists of a Scientist in Charge, a Deputy Scientist in Charge, a Beamline manager, 3 Beamline scientists, 1 postdoctoral fellow and a technician. When requested, Users' groups are joined by the SPL group scientists and PhD students experienced in MSB operation.

Availability of appropriate logistical laboratory environment

As illustrated in Figure 1, the SPL and MSB have the use of CUP mechanical machine shops with technicians, who manufacture any custom elements upon short notice. There is also a general support agreement between CUP and the Vakuum Praha Co. (VP) residing, like the SPL, in the Troja campus. Based on this agreement the VP manufactures UHV chambers, components and more complex vacuum mechanical parts for the CUP laboratories, the MSB and their user experiments. An optical workshop in the CUP Troja campus supplies optical elements and components made of glass, quartz and a selection of other materials.

Electronic and software servicing are arranged with SPL PhD students and staff members. Any just-in-time adjustment and interfacing of user equipment (typically specimen holders, software experimental control, special settings, etc.) is approved by Senior Researchers in charge of the experimental systems.

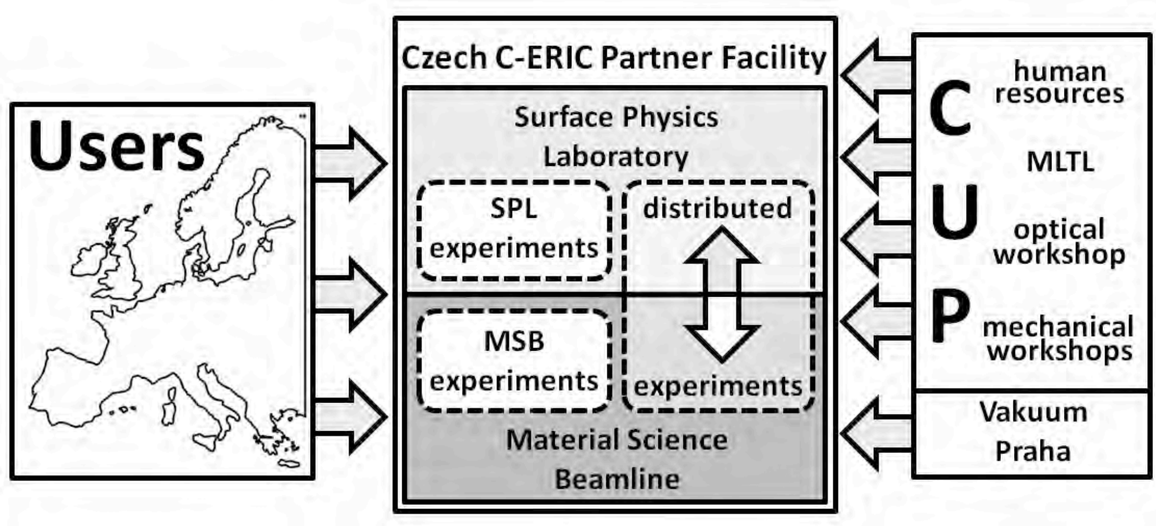


Figure 1. The C-ERIC Partner Facility experiment handling and support diagram: Users will apply to the common C-ERIC portal, and, in the first phase there will be the availability for one or a combination of three types of experiments - SPL, MSB or distributed . The approved User projects will take place at the appropriate facility locations (Prague, Trieste or both) with a full support from CUP staff, research facilities and workshops and the local Prague contractor Vakuum Praha, depending on the users requirements, other Partner facilities will be involved in coordination through C-ERIC.

At need the Users will be supported by CUP facilities for measurements of materials' bulk physical properties located in the Magnetism and Low Temperatures Laboratory (MLTL) at the Troja campus. The available instruments include modern PPMS devices and $^3He/^4He$ Dilution Refrigerators and cover electrical resistivity, capacity, permittivity, Seebeck effect, Hall resistivity, magnetostriction, magnetization, magnetic susceptibility, and thermal conductivity and expansion over temperatures from 15 mK to 400 K, magnetic fields up to 14 T and pressures up to 25 GPa.

All laboratories have established procedures of procurement, storage and handling of consumables. Special and hazardous substances are tracked and handled appropriately. Relevant trainings on work safety are arranged both regularly and at a short notice when needed.

Previous experience in “free open access” operation and/or established policy in “free open access” operation and evaluation mechanism of users impact;

The Partners have ten years of experience in running the MSB laboratory as an open access facility. In 2002 the MSB was selected as a center of fundamental research in the framework of International cooperation with important International Institutions and “*Center of material research by using synchrotron radiation*” financed by the Czech Ministry of Education. This funding and the support of the involved institutions (CUP, CAS and ST) allowed running the MSB as a ***free open access facility***. In addition, the SPL has always **supported the MSB user experiments** by providing its Prague laboratory equipment for supplementary experiments such as sample preparation process refinement, sample pre-checking and reference measurements.

Every year 70% of total beam time is available to external users. All experiment proposals are evaluated by a **peer review committee** and, when recommended, are scheduled and carried out. Between the years 2002 and 2011, a total of **193 experiments** were recommended by the peer review committee, scheduled and carried out. Following the Cooperation Agreement, around **60 experiments** were performed by users from Czech institutions and, on top of that, approximately **50 internal experiments** were performed by the MSB institution teams. The MSB has hosted many international research teams from different countries, particularly from Italy, Germany, France, Greece, Great Britain, Finland, Japan, Moldova, Ukraine, Hungary and Slovakia. Most user teams were internationally diverse and involved Czech scientist and PhD students.

The Partner laboratory in Prague has been available for external users before now. The SPL is part of CUP and its operation is funded in part from the CUP institutional budget and in part from research and cooperative grants. Thus, the external free access has mostly been limited to MSB Users and to close collaborators from around the world (National Institute for Materials Science in Tsukuba, Japan, Erlangen University, University of Burgundy, University of Bahia Blanca, Argentina, Technical University in Düsseldorf, Germany, University of Modena, Italy). Several experiments have also been carried through by SPL scientists for external industrial clients. From these experiences the Partner laboratories have established procedures for machine time scheduling and User support. With the commencement of operation as C-ERIC Partner Facility, the SPL will put their machine time scheduling onto a common platform, as agreed on with other C-ERIC partners. We envisage it closely following the principles used and fine-tuned in the operation of the MSB at Elettra. This will include setting up and maintenance of a web-based machine time calendars and secure data servers with authorized remote access for the Users.

Existence of the ICT support infrastructure for data storage, handling and remote access;

All laboratories of SPL and MSB are fully wired with gigabit Ethernet connections. Every system contributed to the Partner Facility has a dedicated control computer with Internet access. Data storage and backup is being done locally and a secure VPN access is granted to users for remote data recovery. Upon the establishment of the Partner Facility the SPL will set up an SFTP server to store a copy of the data generated at each experimental system, so that Users can access their data independently from the operational status of the experimental stations. The departments, to which the Partner laboratories belong, have staff responsible for internet connectivity and associated services. The maintenance of the data servers and the related user support will come under their competences.

Perceived organizational and institutional ability to provide the services proposed and to act as national reference point to outreach the scientific and technical communities.

The Charles University in Prague, the parent institution of the participating Partner laboratories, is the largest university in the country. It is a public institution and its research funding comes directly from the Czech Science and Education budget and through the Grant Agency of the Czech Republic. Among other distinctions the Faculty of Mathematics and Physics (FMP) ranks highest in quality and productivity of fundamental research in the country and is recognized as such nation-wide.

The FMP has, through its departments, active collaborations with other research facilities across European Union and other European countries. The SPL group has a world-class expertise in surface analysis, thin film growth and studies of reaction mechanism on catalyst surfaces. This expertise is used to develop novel tailored nanomaterials, particularly for the application in planar and conventional micro- and small-size reactors by combining fundamental surface science, model catalysis, operando spectroscopies and advanced TF deposition techniques.

Potential complementarities to other proposed Partner Facilities, in the perspective in offering integrated analytical/synthesis capabilities in view of current and future research topics.

MSB-SPL Partner Facility is offering to the Users a large range of top quality analytical tools in the field of surface science and nanotechnology, including a state-of-the-art soft x-ray photoelectron spectroscopy instrument. Among the C-ERIC Partner Facilities, the SPL-MSB brings the surface science expertise and instrumentation, which has no or hardly any overlap with the others, which cover the high resolution microscopy, x-ray diffraction, neutron scattering, structural analysis nuclear magnetic resonance and complementary energy range spectroscopies of C-ERIC Elettra beamlines. Each of the Partners can and does solve specific problems by itself and efficiently so. However, as C-ERIC members we expect the Users to approach the consortium with proposals multidisciplinary and complex enough to require a parallel or subsequent investigation of materials from several points of view, e.g. surface *and* bulk, structure *and* electronic/magnetic properties, fundamental *and* applied tasks, etc., in one project. Then the power of C-ERIC as a union of facilities will demonstrate itself in collective planning and synchronization of work between the required Facilities. Apart from this we also expect that sample treatments will be necessary that are unavailable all at one Facility, but will be accessible by circulation of specimens between the Partners. For this the SPL-MSB brings the thin film and nanowire deposition infrastructure and FIB/EBL nanofabrication as its share. We believe that the selected instrumentation and specialist work force together bring a high added value to the C-ERIC project with a potential to substantially contribute to the excellence of the consortium. The united efforts and synergy of the partners, in which the SPL-MSB staff are ready to participate, will bring the consortium level with the current state-of–the-art material science infrastructures around the world.

The “background environment” of the Laboratory/Institution hosting the proposed infrastructure, in view of the development of the best educational, technical training and industrial returns.

Previous experience in European networks

Our international collaboration is organized on the foundation of our past and present research projects and contracts. These include the 6th EU FP “Nanostructures for Chemical Sensors”, the 7th EU FP “FUNPROB”, the cooperation with Univ. of Erlangen (Prof. Jörg Libuda) on “Investigation of ceria based surfaces” and participation in the Int’l Union of Vacuum Science, Technology and Application (IUVSTA) through the Czech Vacuum Society. SPL is actively involved in COST Action MP0903 “Nanoalloys” and COST Action CM1104 “Reducible oxide chemistry” projects with chair of SPL, Prof. Matolin, member of the management committees.

Previous experience in multiple analytical/synthesis techniques;

The SPL and MSB track record in the use of a synthesis and analytical techniques is long, exhaustive and corroborated by many publications in peer review journals, a list of which is accessible on the SPL departmental web pages (3). The experience centers on fundamental properties of thin films and materials surfaces, but includes also applied research with prototypes of functional devices: catalysts, sensors, and fuel cells. The MLTL has shown its productivity (4) in production and measurement of transport properties of novel electronic, magnetic and correlated materials at low temperatures, high pressure and high magnetic field.

Statement on the expected outcome and added value of entering in the C-ERIC.

The SPL and MSB will bring existing, well established, modern and productive facilities into C-ERIC. Along with the open access to our equipment we offer our world class know-how in surface physics and chemistry and a network of our past and present collaborators around the world. Establishing new collaborative links within the region will

(3) http://physics.mff.cuni.cz/kfpp/php/journal-list.php

(4) http://www.lmnt.cz/index.php?option=com_content&view=article&id=13&Itemid=31

open new areas of interest and application to all participants and will benefit the countries and their industry.

General experience in EU and/or international collaborations and contracts;

2002-today "**Joint School of Doctoral Studies**" a joint venture of CUP and NIMSin Tsukuba, Japan

2004-2007 "**Nanostructures for Chemical Sensors**", EU 6th FP, NMP. CZ 290 k€

2006-2011 "**Condensed Matter Physics – New Materials and Technologies**", Ministry of Education of the Czech Republic (MEdCR), 450k€

2011-2014 "**Inverse Catalysts**", Cooperation with Brookhaven National Lab, USA, MEdCR, 65 k€

2007-2011 "**Nanostructured catalysts**", Czech Academy of Sciences, 140 k€

2006-2011 "**Center of materials study using synchrotron radiation**", MEdCR, 2163 k€

2010-2013 "**New catalysts for hydrogen fuel cells**", Grant Agency of Czech Republic 103 k€

2009-2012 "**Physics of nanostructures**", PhD project, CZ Grant Agency 775 k€

2008-2012 "**Czech Institutions at Synchrotron Elettra**", MEdCR 550 k€

2008-2012 "**Study of properties of single crystal model catalysts**" Cooperation with University of Washington, USA, MEdCR, 56 k€

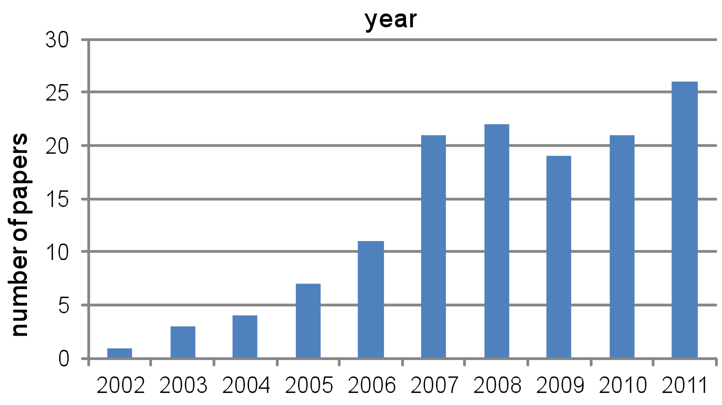
2010-2011 "**Investigation of low temperature catalysts**", Cooperation with Univ. of Bahia Blanca, Argentina, MEdCR, 5.2 k€

2011-2012 "**Investigation of ceria based surfaces**" Cooperation with Univ. of Erlangen (Prof. Jörg Libuda), Germany, MEdCR, 8 k€

2011-2013 Participant of **International Union of Vacuum Science and Technology Application** for the Czech Republic, MEdCR, 20 k€

2011-2014 EU 7th FP - the Marie Curie-people project **FUNPROB**, MEdCR, 50.2 k€

Publication record (contents, numbers and quality) of in-house research;



MSB results were published in around 130 articles in international peer review journals between 2002 and 2011. The graph on the left shows the number of published articles per year since its commencement. It demonstrates that from the year 2006, there was an important increase in scientific output. From 2007, the number of published papers was around 20 per year, and the MSB continues to rank as the Elettra's most productive beamline. We also achieved a continuous increase of the average impact factor (IF) of published papers from 1.9 in 2006 to 2.45 in 2010. In the year 2011, the average IF is 4.1 with one article published in Nature Materials. Beside MSB activities many other articles (see references in footnotes (3) and (4)) were produced as an in-house research. The 10-year track record of SPL publications contains 155 publications of results, many of which were achieved in part or in full at the MSB.

A list of other research, educational, industrial activities in easily connected surroundings.

As a laboratory of the Department of Surface and Plasma Physics of FMP CUP, the Surface Physics Laboratory arranges seminars with invited speakers from around the world. Some of the SPL faculty members are on the Board of the Czech Vacuum Society and organize regular industry fairs as well as specialized summer schools.

In terms of industrial activities MSB-SPL focuses mainly to fundamental science. For this reason, so far only limited access to surface analysis techniques is provided to industry. Recently we offered surface analysis and microscopy expertise to companies specialized in coating technology (jewellery and diamond like carbon).

In the frame of C-ERIC, SPL can provide access to industrial users needing surface analysis services, in agreement with a future strategy of C-ERIC. The possible interested industrial partners are the coating companies and enterprises developing new materials for energy, particularly fuel cell technology.

Presentation of the C-ERIC Partner Facility

Budapest Neutron Centre

Address: Budapest Neutron Centre / Centre for Energy Research
Hungarian Academy of Sciences
Konkoly Thege str. 29-33
1121 Budapest, Hungary

Web-page: www.bnc.hu

The proposed partner facility is the Budapest Neutron Centre (BNC); a consortium of 2 research centres located at the KFKI Campus of the Hungarian Academy of Sciences in the outskirts of Budapest. This campus is Hungary's largest research complex hosting several research units and a number of spin-off and other commercial companies totalling nearly 2000 people. The Centre for Energy Research operates the Budapest Research Reactor (BRR) itself and a number of neutron research facilities. The Wigner Research Centre for Physics operates 8 experimental stations at BRR's neutron beam-lines. The reactor and its instrument suite is the country's largest research infrastructure.

BRR is a tank-type reactor, which is moderated and cooled by light water; it was first put in operation in 1959. A full-scale reconstruction started in 1986 and the upgraded 10 MW reactor has been in operation since 1993. The reactor is operated in 10 days continuous cycles, total 150-160 days per year in average. A core conversion to low enriched uranium fuel has been completed in early 2012 and the reactor operation at the current circumstances can be foreseen until 2023. The fresh low enriched fuel stock on hand ensures the stable reactor operation until 2016. A Cold Neutron Source (CNS) at a tangential beam port feeds 3 neutron guides upgraded in 2007. A thermal neutron guide was installed in 2004 for a time-of-flight spectrometer.

Quality and the potential of the facility to support excellent science at the cutting edge, and offer a service to external users

Type and quality of the instrumentation

BNC experimental stations cover a wide variety of measuring techniques and scientific fields. The high profile instruments operated around the research reactor and offered for the C-ERIC programme are listed below.

Prompt Gamma Activation Analysis, PGAA instrument is one of the two operational instruments in Europe and a leading PGAA laboratory of the world. It is dedicated to perform non-destructive multi-elemental / isotopic analysis of various samples, including archaeological object up to tens of centimetres in diameter, rock samples, catalysts, samples of inactive tracing, fissionable materials, etc. The $1.2x10^8$ n/cm^2s neutron flux in the target chamber and the superb background conditions enable the users to study the average composition of materials from a few hundred milligrams to several grams in a short period of time.

The **Neutron-Induced Prompt-gamma Spectroscopy (NIPS)** instrument is amongst the few working neutron-capture facilities of the world that is designed for studying cold neutron capture. Its excellent background ratio and $3x10^7$ n/cm^2s neutron flux is ideal for performing γ - γ coincidence studies on various samples with the multi-parameter data acquisition system of local design. Samples of 10 milligrams to several grams can be studied with a number of several closely mounted detectors to determine the nuclear structure of the target nuclei or to measure decay-properties of fissionable materials. The NIPS instrument has recently been equipped with Compton-suppression enabling to serve as a second PGAA station.

The **small angle neutron scattering (SANS)** instrument is a classical pin-hole device. It covers a Q-range from 0.002 $Å^{-1}$ to 0.5 $Å^{-1}$ allowing density, composition and magnetization fluctuations to be measured in materials on a length scale of 5 Å to 1400 Å. The wavelength resolution can be varied by the neutron velocity selector between 12% and 30%. The beam is formed by a 5 m long collimator with variable parameters. Scattered neutrons are detected by a 64x64 pixel detector of BF_3 gas.

The **GINA polarized-neutron reflectometer** is designed to study structural and magnetic properties of thin films, multilayers, interfaces and membranes. GINA is supplied with cold neutrons of wavelength 0.31 to 0.52nm (Be-filtered) and lambda-resolution of 1.2% of the PG focusing monochromator. The 200x200mm^2 2D detector allows for studying specular and off-specular scattering to study depth profiles and in-plane structures, respectively. GINA has a polarization and analysis option for specular scattering. Samples of 10x10 to 50x50 mm^2 surface can be studied in the temperature and external magnetic field range of 9 to 300 K and 0 to 650 mT, respectively.

TOF, a high resolution time-of-flight powder diffractometer is installed on a thermal neutron beam in a separate guide-hall. Its monochromator consists of a 5 chopper system with supermirror neutron guides. In high resolution mode the short (10µs) neutron pulse and the 25 m total flight path allows one to obtain a neutron diffractogram with a 10^{-3}Å accuracy in a single measurement, while in low resolution mode liquid diffraction can be performed with high neutron intensity of neutrons of up to 15 Å^{-1} scattering vector. This is a highly demanded instrument by users for various research programmes such as structural analysis of multiphase alloys, strain analysis in structural materials, identification of archaeological objects (a typical highlight: The structure and chemical composition of “mankind’s earliest iron tool” from a London collection was recently studied by TOF diffraction, PGAA and neutron tomography. The meteoritic origin was confirmed and it was first discovered that this 5500 years old “iron pearl” was made by wrapping of a metal sheet). The TOF instrument serves also as a unique facility for developments in time-of-flight techniques with increasing interest of using sophisticated chopper configurations at new neutron sources.

The **PSD, a two-axis neutron diffractometer** offers the possibility of a wide range of atomic structure analysis, including both crystalline and disordered materials. The instrument is unique in Central Europe for the short-and medium range structural investigations of amorphous solids and molecular liquids due to the high counting efficiency based on the up-to-date detector system and due to the special knowledge of the staff in the reverse Monte Carlo modelling of the 3-dimensional atomic configuration and data treatment.

The **TAST triple–axis spectrometer** provides flexible operation for high intensity / resolution measurements. TAST is used in a multi purpose regime, e.g. for high-resolution diffractometry, strain analysis, quasielastic and inelastic scattering as well as for thermal beam irradiation and transmission tests. This instrument is also used as a dedicated – unique in the world – neutron holography device to reveal local structures at atomic level resolution.

Some other experimental stations such as the ATHOS cold neutron triple axis spectrometer, REFL (reflectometer for industrial use), MTEST diffractometer, the RAD radiography station, the NAA fast rabbit system for neutron activation analysis, the BAGIRA in-pile irradiation rig can also be used in the C-ERIC program, although these instruments are less relevant to the current scientific proposal.

New developments: 2 new instruments of innovative approach are under commissioning. The in-beam Mössbauer spectrometer will largely extend the variety of usable Mössbauer isotopes. A second SANS instrument will not only increase the measuring capacity, but also serves – by using sophisticated focusing optics – for extending the momentum transfer range. For the next two years a BNC infrastructure development is proposed: it is an essential extension of the capacity and a major upgrade of those experimental stations at BRR, which were installed in the past decade and unambiguously proved themselves as high performance and highly demanded infrastructure components. The current investment serves those developments which are necessary for the major improvement of the competitiveness at international level as well as the extension of capacity to serve the current scientific programmes of our institutes and the external user demand. The instruments – TOF, REFL, GINA, DNR – and ancillary equipment in the scope of this project have been installed and developed at a basic/minimum operational level, thus the experience gained in the past few years has established the development concept for the upgrade. Most of the items to be installed are products of recent developments, though based on mature technologies. For example, the electronic control and data acquisition system (ECDAS) to be installed on several instruments is standardized cutting-edge equipment; this is the result of a joint development of BNC and spin-off companies. Considerable effort has been focused on sample environment development. A cryostat down to 9 K, furnaces up to 1100 deg C, electromagnet of 2T field and various set-ups for kinetic/stroboscopic measurements were put into operation. Most of these devices are shared amongst several instruments.

The typical measuring time on our neutron instruments vary between 3-10 days. Offering in average 30 days of the available beam-time on the highlighted 7 existing BNC beamlines will yield in about 25-30 experiments per instrument per year. With some eventual experiments on the other stations and the 2 instruments under commissioning within C-ERIC we expect to reach about 12-15% of the total BNC experimental capacities.

Availability of adequate support staff

Smooth running of the user programme i.e. to effectively allocate beam time to diverse activities requires careful coordination by the user office. The access to specific instruments involves first an administrative support (arrival and departure of users, room reservation, etc.). BNC users are supported by an experienced team of scientists and engineers helping them in performing their research. The total staff number is 110 persons (63 scientists and technicians, 45 reactor operation personnel, 2 user services). Each experimental station has an “instrument responsible” and the role of the “local contact” for a user experiment provided by at least of a senior scientist and a junior scientist or post-doc. Supervision and assistance by the local contact (setting up beam and sample environment), consulting and assistance in data reduction and evaluation, preparation of joint publication etc. is provided. The instrument scientists are available on site or on call to solve experimental problems. Visitors also benefit from the scientific environment of the KFKI campus where the Budapest Research Reactor is located. It is in an environment of high-level scientific and technical development activity. The campus hosts 3 research centres including scientists of nuclear and particle physics, solid state physics, optics, material science, mathematics and computer science, excellent high-speed internet connection. The KFKI campus is a vivid place of scientific discussions; seminars, conferences and workshops. The users perform their experiments in a multi-disciplinary environment, which stimulates cooperation and cross-fertilization; users can easily have contacts with scientists in various fields, from fundamental physics to archaeology. On the Campus site a large variety of techniques in experimental physics, chemistry or materials science is available, small business companies on site can provide assistance in electronics, mechanical engineering, computing etc.

Availability of appropriate logistical laboratory environment

BNC users may have access to various services at the KFKI campus. Textbooks and scientific journals are available – also online - at the KFKI library, which is the largest and best served physics library in Hungary. User office space with internet connection, computers, WIFI is available. Sample preparation and characterization facilities are also available on-site at the campus laboratories of various profiles from electron microscopy, through hot cell manipulators, optical spectroscopy methods, and chemical analysis to X-ray facilities. Other services for the out-of-experiment periods include two canteens, food-store shop, cafeteria, as well as logistical support (e.g. travel arrangements) and a guest-house on-site offers a few rooms for most inexpensive accommodation.

Since 20 years the Budapest Neutron Centre has set-up an International Scientific Advisory Council (ISAC) to monitor scientific and technical quality and developments. 15 members of ISAC are internationally renowned scientist from Europe, but with strong emphasis on the Central European region. F. Mezei, an outstanding scientist in neutron research is the current chair of ISAC, which advise on all relevant aspects of the development on human resource policy, scientific programs, technology transfer and industrial applications as well as instrument developments.

Previous experience in "free open access" operation

BNC offers nearly 2000 instrument beam-day per year. 60% of this BNC capacity is "free open access" and is based solely on peer review selection of the proposals received on two yearly calls. An international open access user programme has been operational since 1999. It is organized via the BNC web pages (www.bnc.hu). A researcher whishing to use a BNC instrument prepares a proposal and submits it to the user office. All proposals go through the same evaluation procedures. First the local contact makes a feasibility note on the proposal, such as technical feasibility and time schedule. The pre-selected proposals are distributed to the user selection panel (USP) members via internet. They evaluate the proposals. The user office provides feedback to the applicants. Special attention is paid to the rejected proposals; a detailed written explanation is given to the applicant. The local contact of the experimental station schedules the projects and supervises the experiment. The result of the project is jointly published by the user team and the local scientific staff.

The User Selection Panel members are recruited from the main European neutron centres. The competence of the 11 members (including 2 from Hungary) covers the entire research activity of the facility. Panel membership is rather stable, one to two members change every year. Two deadlines (May 15, October 15) for submission of proposals establish the high level scientific evaluation and suitable scheduling of the available beam time. Fast track application is also available for urgent cases. The user office collects the applications and circulates to the panel members electronically. The decision is made via electronic voting in the spring proposal period and via personal discussion during the annual User Panel and International Scientific Advisory Board meeting in the autumn proposal period. The principles of the proposal selection are: 1. the proposal should meet the advertised content and format requirements. 2. No interested party is involved in the selection process. 3. All proposals are reviewed by the panel members responsible for the specific field. 4. Consistency is ensured by an identical evaluation procedure to all proposals.

The selection criteria to be applied by the panel members, approved by the International Scientific Advisory Council, are i) the scientific merit, ii) PhD or diploma work involvement, iii) new research field, iv) new user, and v) user from a country where no alternative facility for the project exist.

The Budapest Neutron Centre is one of the 8 neutron sources in Europe, which offer international free access, and it has a particularly important role in Central European region. BNC provides neutron research opportunities in the region – according to a survey of the European Neutron Scattering Association – to around 600 potential neutron users. High demands for neutrons can be demonstrated by the number of EU refund-eligible users (44-55 users/y) and by the number of international users, which is altogether around 100-110. These users were coming for example in 2010 from 14 countries, most of the from our neighbor countries, but also from Russia, China, Morocco.

C-ERIC will certainly play an important role in enhancing this regional aspect for transnational access via the cross-disciplinary utilization of facilities and an outreach to new users will extend not only the use of BNC and other analytical facilities in our region, but may help our users also to access to world leading cutting-edge facilities like ILL, ESRF, ESS, X-FEL etc.

Existence of the ICT support infrastructure

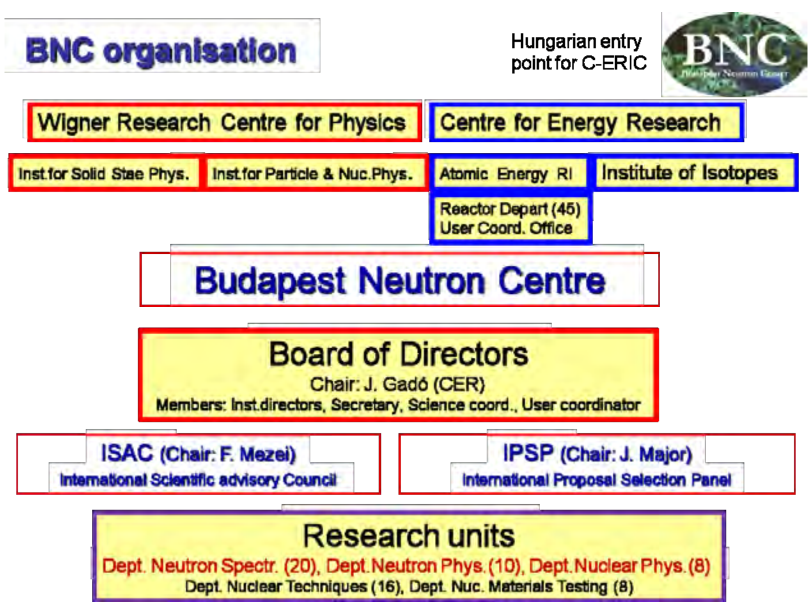
The KFKI Campus Local Network and Computing Centre is based on switching technology with a backbone of 100 Gbit/sec, with 100 Mbit/sec available for desktop computers. This is one of the the country's largest computing environment, it is also the national hub for CERN-based research, thus with extended computing capacities. BNC itself is well connected to this local network with all security measures (also required for the nuclear reactor environment).

Remote measurement control for the GINA and TAST instruments is routinely used and is being extended for several other instruments. Data reduction software for extensive data collection and analysis (e.g. for 2D SANS spectra fitting, RMC analysis, PGAA data-base for nuclear reactions) are available.

Perceived organization and institutional ability to provide the services proposed as national reference point to outreach the scientific and technical communities

BNC is a consortium of research institutes of HAS, which is the most important R&D organisation in the country, thus within its structure the outreach to other research units of similar profile is facilitated by the institutional means of the Academy. Close collaborations exist with the relevant research units like the ATOMKI nuclear research centre in Debrecen, Biology Research Centre in Szeged and the Centre for Natural Sciences in Budapest (this latter has a large materials research unit/outstation at our KFKI Campus). Since 2005 BNC is leading a domestic funded project named NAP – this means International Large scale Facility Collaboration project. In this NAP framework BNC is representing the Hungarian neutron community in CENI towards the ILL membership. BNC and its institutes have numerous bilateral collaborations in the field of neutron, synchrotron materials science and other fields. Hungarian representative organisations for membership at ESRF and X-FEL are chaired by scientists of Wigner RC. Several formal agreements ensures the direct link as C-ERIC entry point for various national large scale facilities like the ATOMKI proton accelerator laboratory, X-ray facility group of the Chem. Res. Centre. Outreach to university research groups is also provided by formal agreement (e.g. PhD schools) and various projects supported by national funding agencies (OTKA, HAS...). Particular importance is devoted to several large equipment groups as supportive activities for C-ERIC, such as the MBE laboratory at Wigner RC, the biology sample characterisation equipment suit at Szeged.

The **Centre for Energy Research** of the Hungarian Academy of Sciences is one of the legal entities and the **coordinator of the BNC** consortium. According to the BNC consortium agreement (CA) as well as the engagement letter sent to the Ministry of National Economy in C-ERIC matter, CER will provide the proper legal and administrative framework as a partner institution for C-ERIC and will act on behalf of BNC units. Within BNC the C-ERIC related internal structure, management scheme, responsibilities and procedures will be governed by the CA extended and endorsed by the BNC Board of Directors. C-ERIC related scientific and technical questions will be addressed also to ISAC. The Proposal Selection Panel will be involved in setting up the similar C-ERIC body. The following chart shows the organization of BNC.



Potential complementarities to the proposed Partner Facilities, in the perspective of integrated analytical/synthesis capabilities in view of current and future research topics

Neutrons are very important tools for exploring and modification of materials features at microscopic level. They have unique properties: charge neutrality and deep penetration, magnetic moment, large scattering cross section for light elements such as hydrogen and oxygen, sensitivity to neighboring elements and various isotopes as well as most importantly, unique kinematics that allow simultaneous determination of position and motion of atomic, molecular or nano-scale structural units in materials. Neutrons are complementary to photon and electron methods and other laboratory based techniques such as electron microscopy, Mössbauer or laser spectroscopy etc. Neutron based research plays crucial role and has very important potentials in science and technology, not only in exploratory research and emerging fields as nano-and bio-technologies, but also non-destructive chemical and structural analysis has become an important tool for identification, provenance and other studies of archaeological artifacts. Thus, neutron source facilities are important class of analytical research infrastructures.

Within C-ERIC synchrotron radiation techniques like SAXS and IUVS are most powerful tools complementary to neutron scattering methods, (SANS and INS, respectively). In the research of biological membranes e.g. related to photosynthesis – as a crucial field in energy/biology research – SANS and SAXS are complementary to reveal structural features for photo-conversion mechanisms in plants. NMR, Electron Microscopy, Raman spectroscopy provide chemical information together with topological data for understanding complex mechanisms. Austrian and Czech beam-lines at Elettra as two C-ERIC facilities may act as direct joint measurement partners in various soft matter experiments.

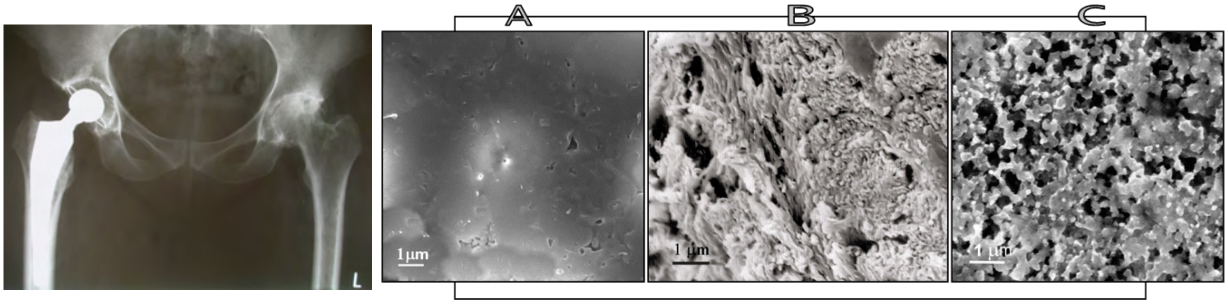
Previous experience in European networks

BNC was one of the first to won an EU networking grant in 1994. This WENNET project aimed to set up a network and coordinate neutron research activities in a few CE (AU, HU, CZ, SK, PL) countries together with western countries (DE, FR, IT). BNC made part of the consortium of research institutes at the KFKI site receiving an EU grant for infrastructure development. Within this frame BNC institutes were awarded the ***"Centre of Excellence"*** title. BNC participates in various EU FPs since the very beginning of these actions. Recent or current running projects are: ANCIENT CHARM (EU FP6 STREP 2005-09), EU FP7 – NMI3 (INFRA-226507/2009), NMI3-II/2012, EU FP7 – CHARISMA (INFRA-228330/2009), EFNUDAT (EURATOM 2007-10), MANREAD, (IAEA 2007-11), FP6 DYNASYNC project (www.dynasync.kfki.hu)

Previous experience in multiple analytical/synthesis techniques

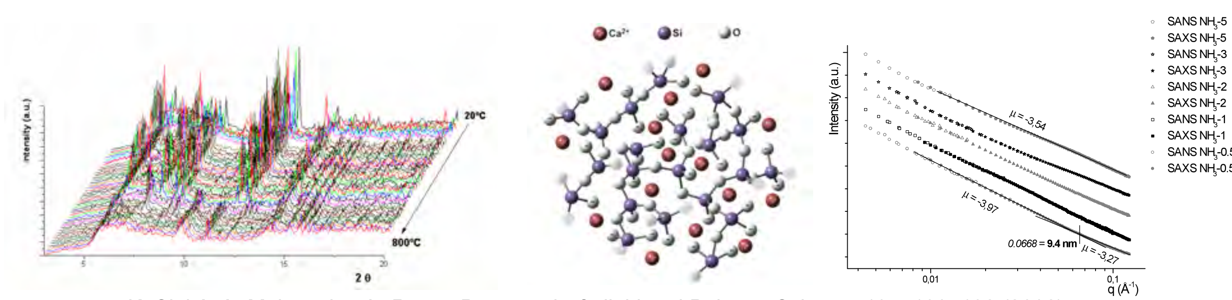
BNC offers the possibility of accessing its different instruments/preparation laboratories. Moreover, it is possible to characterize samples off line at the KFKI Campus based analytical facilities on specific aspects.

Here we give a recent example of a research project, where multiple analytical/synthesis techniques were applied in solving a complex research problem. From the ELTE Budapest University, Faculty of Chemistry a research team applied for neutron beam time at our SANS facility for the investigation of biocompatible ceramics. Since the discovery of Bioglass® in the early 1970s the structure and biocompatibility of different composite calcium-silicate glasses is in the focus of medical application studies. This health-care related research topic is in the scope of our very highly ranked priority research activities. Entering this task it turned out to be a very complex problem both in the aspect of sample preparation techniques and investigation of nano-scale structural approach to reveal materials features. We studied the structure and bonding properties of different calcium (Ca:Si= 0-1:1) and ammonia (NH_3:Si=0.5-5:1) concentrated calcium silicate ceramics prepared by sol-gel method. The effects of chemical composition and temperature on the ceramic structure (topological arrangement at atomic level and porous structure at nano and microscopic scale) were evaluated by electron microscopy, optical, spectroscopy, X-ray and neutron scattering, NMR methods (**FTIR, NMR, SANS, SAXS, NRD and XRD)**.



Bone replacement Melt quenched ceramics Bone Sol-gel CaO-SiO2

The above figure (A,B,C) shows the electron microscopy images of the bone structure and ceramics prepared by two techniques. In our work the ceramics were produced by a low energy-consuming sol-gel method. Without any catalyst, optically clear but strongly fragile gel samples can be obtained. Due to the fast hydrolysis in acidic medium loose, randomly branched structures can be obtained – rather appropriate for bone banding. Base-catalyzed reactions yield more dense materials due to the longer hydrolysis time, which can provide the possibility for the aggregation of particles into the most thermodynamically stable arrangement. In order to increase the bioactivity phosphate content were built up into the system. Starting from the SANS proposal the present work was largely extended to use several other techniques.



K. Sinkó, A. Meiszterics, L. Rosta; Progress in Colloid and Polymer Science, 135: 130–138 (2008)

The above picture shows some structural investigations. The left figure corresponds to an X-ray diffraction pattern showing the evolution of the silica structure from an amorphous state to crystalline one (atomic arrangements in the middle) due to the thermal treatment. The figure on the right is a comparison of SANS (at BNC spectrometer) and SAXS (DESY synchrotron beamline) patterns revealing in complementarity the surface fractal structure of the obtained ceramics. In addition, we determined the FTIR position of Ca-O-Si bonds in various systems. The Si-O-Ca vibrations were identified at 965 cm^{-1} in the IR spectrum of dicalcium silicate hydrate; at 930 cm^{-1} in that of dicalcium silicate; at 890 cm^{-1} in that of mono-calcium silicate and 920-930 cm^{-1} in the amorphous calcium silicate samples. Comparing the 31P MAS NMR and XRD data we could identify that peaks are attributed to β-$Ca_2P_2O_7$ phase, also a γ form is present; and δ-$Ca(PO_3)_2$ as well as Si-O-P in $2Ca_2SiO_4{\cdot}Ca_3(PO_4)_2$ phase are identified. Finally, this 3 years project was completed by a successfully defended PhD thesis at ELTE University (A. Meiszterics).

Expected outcome and added value of entering in the C-ERIC

By entering C-ERIC, it is expected that the Hungarian partner will be able to offer to scientists of the C-ERIC countries as well as to external users the unique possibility of using neutron techniques; and together with the other institutions of the consortium an extended set of synthesis/analytical techniques. C-ERIC will be an institution capable to offer a wide range of possibilities in terms of solving scientific and technological problems ranging from a single shot experiment of – say – a few days of neutron scattering (or X-ray, or TEM, or NMR ….) and also to approach highly complex subjects requiring several techniques both in sample preparation and characterisation to complement each other. Such complex studies may appear as a continued and extending series of experiments, or they can be presented as already well thought and established long term projects. For such kind of complex experiments C-ERIC is an ideal solution to provide a single door entry point for a multiple facility project, and this is within a well affordable geographical area. This will enhance the possibilities for scientists from less-favored countries to test their ideas without having to overcome in their home country the initial investment and time barrier in terms of instrumentation. At the same time, this set of instruments will be available for scientists at the various centers of C-ERIC: this will allow fruitful interactions and cross-fertilization by exchange of expertise and of technical solutions. In a longer term both, initial studies as well as thoroughly characterized subjects but requiring further cutting edge equipment, the C-ERIC approach may well serve for further access to highly demanded unique top class facilities.

The "background environment" of the Laboratory/Institution hosting the proposed infrastructure, in view of the development of the best educational, technical training and industrial returns

General experience in EU and/or international collaborations and contracts

BNC has long records in international collaborations and performing joint projects. The reactor is traditionally tightly linked to the International Atomic Energy Agency (IAEA) with its close to Budapest hub in Vienna. Joint technical development programmes, training courses, expert trainings, workshops etc. are in the scope of working with IAEA. Wigner Research Centre for physics is a national hub or major expert organisation for a number of international research institutions such as CERN, JINR-Dubna, ESRF-Grenoble, X-FEL, ILL-Grenoble. The Centre for Energy Research plays an active role in the field of nuclear energy, involved in many OECD, IAEA coordinated research programs, technical cooperation and EURATOM projects. In it role as a member of the East European Research Reactor Initiative, CER takes part in the organization of training programs among the research reactor operators in Central Europe.

Publication records of in-house research

BNC publishes Progress Reports every second year since 1994 (available also on the BNC webpage). The full publication list is given in these reports. Highlights of the given period, a nearly full record of experimental reports, meeting reports as well as a guide to the experimental facilities are published here. The average number of publications per year is in-between 100-120. Below we list briefly a few outstanding results for the last five years (2007-11):

- Application of neutron holography to atomic imaging at picometric level
- New approach in metal structure analysis for cultural heritage;
- Theory of nuclear resonance scattering
- Mössbauer polarimetry
- Isotope ML method for diffusion studies

- Inverse proximity effect in F/S bi-layers
- Development of magnetic neutron supermirrors
- Input Parameter Library for nuclear reaction calculations
- Evidence for an extraterrestrial impact event at 12.9 ka
- First quasi-3D elemental imaging exp. on a combined PGAI and NT setup

A set of most relevant publications to C-ERIC activity were collected for the period of 2007-11, totalling a number of 133 publications, the related independent citations are as 448; cumulated impact factors: 163,646. A few of them are listed below:

1. Deák L, Bottyán L, Nagy DL, et al Phys Rev B **76**, 224420 (2007)
2. Merkel DG, Tanczikó F, Sajti S, Major M, Németh A, Bottyán L, et al, J Appl Phys **104**: 013901 (2008)
3. Merkel DG, Bottyán L, Tanczikó et al, J Appl Phys **109**, 124302 (2011)
4. Firestone R.B,. Revay Z, T. Belgya et al, Proc.Nat.Ac.Sci.US, **104**, 16016 (2007)
5. Capote R, Belgya T et al, Nuclear Data Sheets, **110**, 3107 (2009)
6. Nagy G, Káli G, Rosta L, et al. Photosynthesis. Res. 1 (2011)
7. Orban J, Cser L, Rosta L, et al. NIM **632**, 124 (2011)
8. Rosta L, Mezei F et al. Eur.Phys.J. **66**, 419 (2008)

Other research, educational, industrial activities

BNC and its experimental stations is a declared open-access research infrastructure, thus national and international cooperation is essential. According to the bi-annual BNC experimental reports (since 1994) the number of domestic and foreign groups (research institutes, university groups, industrial companies) involved in BNC utilisation is close to 80 and 60, respectively. BNC makes part of many project consortia, currently four EU FP7 projects are related to the concerned here instruments (CHARISMA and ERINDA) as well as the complete infrastructure projects (NMI3-I and II). We have the NAP VENEUS large project and several OTKA, bilateral, IAEA, EURATOM etc. projects. Thanks to the current planned investment for extending the experimental capacities more Hungarian and C-ERIC partner groups or external users may direct their research towards neutron scattering studies, previously having no, or very limited access e.g. to low temperature polarized neutron facilities. Another example: a large new OTKA project lead by the Debrecen University will greatly benefit of reflectometry developments for studying standing waves in multilayers.

Support of the local authorities

The Budapest Research Reactor has been utilized as a neutron source for basic and applied research or direct applications in various fields of industry, healthcare as well as in exploration and conservation for objects of cultural heritage. Thus the reactor and BNC has a wide national support for the major fields of utilization as follows:

i) BRR is a research and development base for the energy sector. In Hungary 40% of electric energy is produced by the Paks Nuclear Power Plant (4 blocks of 500 MW electric power). The expertise and knowledge accumulated at BRR during the past decades is a solid basis for scientific and safety support for the Paks NPP as well as for the national nuclear regulatory body. BBR also serves as a scientific and development tool in other fields of energy research, both in energy saving and production.

ii) This reactor is also a complex source of irradiations for materials testing and modification, diagnostics in nanotechnologies, engineering, healthcare etc. The radioisotope production – using vertical irradiation channels of the core – is crucial for society. For example, in our country 60 hospitals are supplied by isotopes produced at BRR and nearly 5% of the population is involved in the usage of isotopes mostly for diagnostics but also for therapy.

iii) The most extended utilization of BRR is neutron beam research. This activity results in a significant number of experiments (including PhD and contract-based works). For example in the period of 2007-11, about 150 experiments6year were completed by local staff and in collaboration with national or foreign users coming from university, industrial or other research laboratories.

iv) University education as well as postgraduate and professional training in the nuclear field has always been an important task at BNC. Since 1999 training in neutron scattering has developed into a series of regional events. For example, the 5th Central European Training

School (CETS) was held at BNC in June 2010. These schools provide introduction to neutron scattering with special emphasis on hands-on-training at BRR.

For the above activities BNC benefits a solid support from its umbrella organisation: the Hungarian Academy of Sciences. The Paks NPP is a major supporter of BRR through various contract based activities. The National Atomic Energy Office is an important channel for IAEA projects as well as for important bilateral actions (transporting back spent fuel to Russia, or transition for low enriched fuel – USA gov.)

Potential to influence and support the scientific and socioeconomic growth

BNC is not only a high-calibre research infrastructure; it is, at the same time, a centre of scientific excellence due to the intensive interaction with scientist of the KFKI Campus and also with those of the international user community. The library and the network of the campus as well as its active seminar life is a guarantee for the immediate scientific impact of research results achieved at BNC instruments.

All past, recent and planned upgrades of BNC including the cold neutron source and the installation or development of various instruments resulted in numerous high-level scientific publications or in technological developments. The existing upgrade strategy of BNC continues focusing on excellent scientific and technological results. Therefore, BNC has a high potential to influence and support the growth of science and technology. BNC plays an important role in education in both Hungary and Europe. Scientists of BNC are readers of university courses, MSc and PhD students prepare their theses at BNC instruments. Upgrades of BNC instruments and BNC itself will have, therefore, a major impact to education. BNC and, especially, its development as well as its upgrade and its integration to C-ERIC also contribute to preserving jobs. Indeed, the increased usage of BNC instruments will result in a need for beam-line scientists, technicians, etc. Furthermore the development of BNC instruments will create jobs at BNC spin-offs and other companies. A few figures for this progress can be listed as follows: Since 1993, when the reactor was restarted after modernisation, the staff and personnel at related institution directly involved has increased from 70 to 250 (Y2011). The turnover of companies which would not exist without having a reactor nearby has increased by a factor 200 and today it is about the double of the reactor operation costs (without investments)!

A most important factor of setting-up and being involved in C-ERIC is the way of performing research and technology development in an international multidisciplinary environment by using multiple-technique approach, which brings science and technology closer to people, makes them more understandable and acceptable for spending taxes paid. Examples of the type of analytical research we propose are those topics, which are directly touching a wide population of the society: problems directly related to health – e.g. very rapid penetration of basic scientific results in every-day pharmacology; materials aspects of IT – e.g. more and more sophisticated magnetic storage material; archaeological discoveries – non-destructive identification of origin of high-value finds. Even neutron beam science – or in general nuclear techniques – believed as costly tools of research, can be explained in a perceptible manner and publicly wide dissemination of such scientific results is a convincing way to enhance research in the future and improve in this way the quality of our life.

References:

- Budapest Neutron Centre: Web-page: http://www.bnc.hu
- KFKI Campus, MTA Csillebérc: Web-page: http://www.kfki.hu/
- L. Rosta, R. Baranyai, Budapest Research Reactor – 20 years of international user operation, Neutron News, **22** (2011) 31-36
- Zs. Kasztovszky, L. Rosta, How can neutrons contribute to Cultural Heritage Research? Neutron News **23** (2012) 25-28

Presentation of the C-ERIC Partner Facility

Elettra Sincrotrone Trieste

Address: Sincrotrone Trieste S.C.p.A.
Strada Statale 14 - km 163,5 in AREA Science Park
34149 Basovizza, Trieste
ITALY

Web-page: http://www.elettra.trieste.it/

The proposed partner facility is the Elettra Laboratory managed by the "Sincrotrone Trieste S.C.p.A.", a not for profit research entity under a special legal frame as a firm of national interest, in Basovizza near Trieste and to Lipica (Slovenia). The main facilities of Elettra are beamlines and experimental stations fed by two accelerator-based photon sources: a Free Electron Laser (FERMI@Elettra) and an electron storage ring. Several support laboratories are also available for sample preparation and development, also in connection with the TASC/CNR laboratory on site. The FEL (*FERMI@Elettra*) is new and started its operation at the end of 2010, it consists of two seeded FEL sources: the first one is presently under fine tuning, while the second one will enter the commissioning phase during 2012. The first call for proposal to access the first source for users is presently (March 2012) open and users are expected in late 2012. The only other FEL operating in this wavelength range is FLASH in Hamburg.

Quality and the potential of the facility to support excellent science at the cutting edge, and offer a service to external users

Type and quality of the instrumentation

The beamlines cover a wide variety of experimental techniques and scientific fields, including photoemission and spectromicroscopy, crystallography, low-angle scattering, dichroic absorption spectroscopy, x-ray imaging etc. The present user communities range from materials science, surface science, solid-state chemistry, atomic and molecular physics, as well as biology and medicine. As an example, Elettra offers access to the Inelastic UV Scattering (IUVS) that has the unique capability to access a kinematic region complementary to the region covered by other techniques such as inelastic neutron or X-ray scattering. In particular, using VUV photons, IUVS can investigate collective modes at wavevectors in the range of about 0.1 nm^{-1}. The possibility to excite modes at the nanometer scale is fundamental to shed light on several open problems in the physics of liquids and glasses, phononic and photonic crystals, ionic liquids and hydrogen-bond based systems ranging from simple water to proteins.

The storage ring, after a major upgrade, routinely operates in the novel top-up mode since May 2010 at energies of 2.0 and 2.4 GeV. This allows for stable long term light generation providing around 5000 hours of user operation with high brilliance beams ranging from the infrared to the hard X-ray range. The storage ring has eleven 5 m long straight sections for insertion devices (undulators and wigglers). There are 3 undulators, each of which is feeding either of two beamlines; 1 wiggler which simultaneously feeds two beamlines, 5 more undulators with a single beamline each and a short undulator (1.5m) feeding a further beamline (TwinMic). Users have access to 23 operating beamlines (15 fed by insertion devices and 8 by bending magnets) 3 additional beamlines, presently under construction will become available in 2012-2013 (see Table 1)

Based on previous consultation with the potential user community, FERMI@Elettra offers advanced characteristics, complementary to those of the storage ring, by a novel scheme (based on laser seeding and special magnetic undulators) which allows complete control and reproducibility of the photon beam characteristics such as wavelength, timing and intensity, as well as the control of the photon beam polarization. Three beamlines and experimental stations will be available on FERMI:

- Low Density Matter
- Imaging
- Scattering.

In particular, the Elastic and Inelastic Scattering (EIS) beamline will exploit a time-resolved technique able to extend the conventional Transient Grating (TG) method in the VUV spectral range. It will open up the possibility to study collective dynamics at the nanoscale, thus allowing to probe the dynamics in the mesoscopic range which, so far, could not be investigated by existing laser or synchrotron based instruments. The proposed experimental method will also be a sensitive probe for dynamics, heat transport and electron correlations in nanostructured materials.

A theoretical support group has been actively working in collaboration with the researchers using Elettra, and will be available for C-ERIC

Elettra hosts the Austrian and Czech beamlines which will be part of the related Partner Facilities, and this ensures a strong coordination between the involved Partners.

BEAMLINES	ENERGY RANGE eV	PARTNER
TWINMIC: A multipurpose twin X-ray microscopy beamline for improving life conditions and human health	250-2000	
Nanospectroscopy: SPELEEM and LEEM-PEEM end-station	50-1000	IFF Jülich
FEL: European Free-Electron Laser project	1.8 – 9.5	
ESCA Microscopy: Scanning PhotoElectron Microscopy (SPEM)	200-1400	
SuperESCA: Fast and High Energy Resolution Photoemission and Absorption Spectroscopy	85-1500	
Spectro Microscopy: Angle-Resolved Photoemission microscope	27-95	
VUV Photoemission: Angle-Resolved PhotoElectron Spectroscopy (ARPES) in the VUV range	16-1000	ISM-CNR
Circular Polarization: Dichroic measurements on chiral systems	5-1000	ISM-CNR
SAXS: Small Angle X-Ray Scattering	8000 16000	IBM-ÖAW (A)
XRD1: X-ray Diffraction	4000-22000	IC-CNR
Materials science: Photoemission and X-ray absorption	40-800	ASCR, Charles University of Prague (CZ)
SYRMEP: SYnchrotron Radiation for MEdical Physics	8000-35000	UNITS
Gas Phase: Research on gaseous systems	14-1000	IMIP-CNR, IOM-CNR
MCX: Powder Diffraction Beamline	2100-23000	UNITN, INSTM
ALOISA: Advanced Line for Overlayer, Interface and Surface Analysis	120-8000	IOM-CNR
BEAR: Bending magnet for Emission Absorption and Reflectivity	4-1400	IOM-CNR
LILIT: Laboratory for Interdisciplinary LIThography	1000-5000	IFN-CNR, IOM-CNR
BACH: Beamline for Advanced DiCHroism	35-1600	IOM-CNR
SISSI: Synchrotron Infrared Source for Spectroscopy and Imaging	0,001-3	
APE: Advanced Photoelectric Effect experiments	10-2000	IOM-CNR
X-ray microfluorescence	4000-20000	
DXRL: Deep-etch Lithography	2000-20000	
IUVS: Inelastic Ultra Violet Scattering	11-2008	
BAD Elph: Low-energy Angle-Resolved PhotoEmission Spectroscopy (ARPES)	4-25	
XAFS: X-ray Absorption Fine Structure	2400-25000	ICTP
XRD2: X-ray Diffraction	7000-50000	IIS Bangalore (IN)

Table 1Beamlines on the Elettra storage ring.

Availability of adequate support staff

Users coming to Elettra find a support group of trained scientists helping them in performing their research. The support group of each beamline is composed at least by a senior scientist a junior scientist and a post-doc. The beamline scientists will be available on site or on call to solve experimental problems. The users operate in a multi-disciplinary environment, which stimulates cooperation and cross-fertilization. The facility is in an environment of high-level scientific activity, and users can easily have contacts with scientists in various fields, from theoretical physics to structural biology.

Availability of appropriate logistical laboratory environment

Users have access to several online scientific journals and to the library. Sample preparation and characterization facilities are also available on-site.:

- Micro and Nano Carbon Lab: Preparation and study of carbon nanotubes and several carbon based materials;
- NanoLab: Research on surface confined bio- molecules and self- assembled monolayers using atomic force microscopy;
- Organic OptoElectronics: Properties of organic semiconductors, either molecular or polymeric, and their applications;
- Scientific Computing: Support to research activities by providing advanced algorithms, ICT services and infrastructures;
- Structural Biology: Structural and functional studies of proteins and protein complexes involved in DNA replication and repair, autophagy and genome stability;
- Surface Science Lab: Geometrical and electronic structure as well as the chemical reactivity of a large variety of solid surfaces;
- Theory@Elettra: Theory group funded by the CNR-INFM DEMOCRITOS supporting the experimental activity performed in the laboratory;
- Tomolab: A state-of-the-art X-ray computed microtomography system based on a microfocus source;
- T-ReX: A set of facilities devoted to the study of ultra-fast processes in condensed and soft matter and their applications in technology;

Other services include machine shops and a cafeteria, as well as logistical support and advice. Elettra is part of the Trieste Area Science Park, and more generally of the Trieste scientific environment. This includes world-level institutions such as the International Centre for Theoretical Physics and the International Centre for Genetic Engineering and Biotechnologies, both of which are operated under the aegis of the United Nations, the TASC laboratory of IOM-

CNR, and the Consortium for Biomolecular Medicine (CBM). The users can profit from this environment which provides additional high-level facilities, stimulating interactions.
Elettra's scientific and technical quality and developments are constantly monitored by international Committees (Machine Advisory Committee, Scientific Advisory Committee and Industrial Advisory Panel), which advise on all relevant aspects of the general and development policy, scientific programs, accelerator development, technology transfer and industrial applications.

Previous experience in "free open access" operation

70% of the access to Elettra is "free open access" and is based solely on peer review selection of the proposals received on two yearly calls. The Proposal Review Panel is an independent panel composed of senior scientists active in different scientific fields and appointed by the Elettra laboratory management with the aim of evaluating the general User's proposals.
The panel is divided into seven subcommittees. Apart from proposals for protein crystallography, the Proposal Review Panel meets twice a year, gives a written report for each proposal submitted for the ongoing semester and gives suggestions for beamtime allocation at the beamlines open to the users. The composition of the Panel can be found at the link
http://vuo.elettra.trieste.it/pls/vuo/guest.scientific_review_committee.
Access for protein crystallography is based on proposals accepted continuously and evaluated monthly , in order to speed up access.
The scientific services offered by Elettra are highly demanded by the International research community. As an example, in the period from 2010 -2011, Elettra received 1575 proposals for measurement runs coming from 53 countries (Fig1).

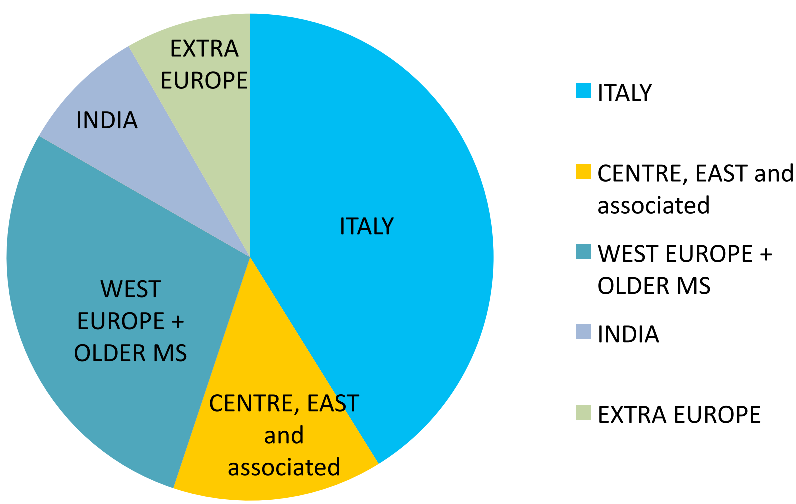


Fig.1 Nationality distribution of the 1575 scientific proposals received by Elettra in 2010-2011

The users from the Center East EU Countries, and from India, reflect the strength of collaborations in developing joint facilities, it is expected that C-ERIC will allow to increase the balance between users from the various Countries in Europe.

Existence of the ICT support infrastructure

The Elettra Local Area Network is based on switching technology with a backbone of 1 Gbit/sec, with 100 Mbit/sec available for desktop computers. The FtpUpload allows easy file transfers to and from Elettra with an outside "partner" that cannot access the Elettra Intranet. It is based on FTP (File Transfer Protocol), with both nominal and anonymous authentication. By the SSH (Secure SHell) service it is possible to connect to the Elettra Intranet from the Internet in a very secure way, or to transfer classified data via SCP (Secure CoPy) and SFTP (Secure File Transfer Protocol). All the computers connected to the LAN can access the file server sincro-share, which shares a big disk area, so to share files among the Elettra people: both private and public areas are available. KNOT (KNots One Tie) is the new cluster for ELETTRA calculus.

Support for remote measurements control for protein crystallography is presently under test. Servers and software for extensive data analysis (e.g. for x-ray tomography reconstruction) are available. A strong synergy with the other Partners in C-ERIC will be based on jointly developing and interlinking the ICT aspects.

Perceived organization and institutional ability to provide the services proposed and to act as national reference point to outreach the scientific and technical communities

Elettra has established enduring working relationships with important Italian and foreign institutions, including various Italian National Research Council Institutes (who have several beamlines integrated in Elettra) , the Academies of Science of Austria and the Czech Republic, UNESCO’s International Centre for Theoretical Physics (ICTP), the International School of Advanced Studies (ISAS/SISSA), The Indian Institute of Science and several Universities in Italy and Europe . These partners are actively contributing to the construction and operation of beamlines and support laboratories. On its site Elettra hosts the National TASC Laboratory (IOM-CNR), a facility for micromanufacturing and nanoscience.

Elettra has a proven track record in the development of high quality research and technological innovation, including the successful fulfillment of common initiatives with partner institutions in Austria, the Czech Republic, Slovenia, Croatia, India, France, Germany and other EU and non-EU countries.

Potential complementarities to other proposed Partner Facilities, in the perspective in offering integrated analytical/synthesis capabilities in view of current and future research topics

Synchrotron radiation is a powerful analytical tool. Techniques like SAXS and IUVS are complementary to Neutron scattering methods, (SANS and INS, respectively) being proposed by Hungary. Protein crystallography and SAXS applied to non-crystallizing proteins are complementary to NMR proposed by Slovenia. X-ray microscopies are complementary to Electron Microscopy, as they provide chemical information together with topological data. Moreover, all SR-based methods give important information on materials grown in synthesis laboratories, allowing, for example, to compare expected electronic structure with the actual one. The different electron beam energy makes Elettra also complementary to the proposed Polish Synchrotron Radiation center were hard x-ray methods will not be available.

Elettra will, in the initial phase of C-ERIC, provide access to a significant fraction of the available time on the instruments which best complement the other Partner Facilities, it is expected that this integration between the facilities will increase wit time and requirements of the users. Based on a first analysis of possible user requirements, in the first two years of operation Elettra will concentrate on the following problems providing access to the related beamlines:

a) Determination of atomic structural arrangement:

1) X-Ray Diffraction
2) Powder Diffraction
3) X-Ray absorption spectroscopy

For *protein studies*, X-Ray based methods (a1&a2) are indeed complementary to NMR (SLO) and to Electron microscopy (RO) and to SAXS (AU). It is therefore envisaged that a multitechnique approach will provide a better insight to the understanding of the structure and functions of proteins, in particular when the Romanian PF will be equipped with cryomodules on one of their TEMs.

The same beamlines will also be used for the *characterization of nanomaterials*, again using the complementarity with the other centers, It is particularly important to stress the possibility to use the laboratory XAFS instrument in RO to perform preliminary measurement before taking the samples to the Elettra beamline (a3).

b) Imaging and microscopy:

1) Soft x-ray microscopy (TWINMIC)
2) Polarization dependent NanoSpectroscopy
3) Angle-Resolved Spectromicroscopy
4) Infrared microscopy

Microscopy and imaging methods with photons are powerful *tools to study matter, including biological matter*, complementary to neutron methods (HU), electron microscopy (RO) and NMR (SLO), because of the capability to get chemical contrast together with the topological one. We see methods b2 and b3 as ideal complement to the MSB beamline of the Czech PF, by adding lateral resolution to the high energy resolution offered by MSB. Also, b2 allows to get information at the nanoscopic level on the size, shape and distribution of magnetic domains, which makes it complementary to magnetic studies performed with polarized neutrons (HU).

c) Inelastic Scattering

As mentioned above, Elettra developed the first Inelastic Ultraviolet Scattering beamline in the world. This instrument is still the only one in Europe. This method allows to explore a region of the q-ω space unavailable to inelastic neutron scattering, thus providing ideal complementarity with the HU neutron beamlines.

Previous experience in European networks

Elettra is one of the laboratories associated with the IAEA, the International Atomic Energy Agency and is part of the primary network for science and technology of the CEI, the Central European Initiative. Elettra is also the Coordinator of the network of all of the synchrotron and free electron lasers facilities in Europe, promoting transnational access to the laboratories and joint research activities in their field. At the time of this writing, a new proposal (Coordinated Access to Lightsources to Promote Standards and Optimization – CALIPSO) has been submitted under call FP7-INFRASTRUCTURES- 2012-1. FERMI@Elettra is already part of the roadmap of the European Strategy Forum for Research Infrastructure (ESFRI) through the EuroFEL initiative (once IRUVX-FEL, from infrared, ultraviolet, X-ray Free Electron Laser).

Previous experience in multiple analytical/synthesis techniques

In several cases the users of Elettra have exploited the possibility to use its different instruments/preparation laboratories. This service has been supported also by the possibility to characterize samples off line, to focus the SR based analysis on specific aspects.

Expected outcome and added value of entering in the C-ERIC

By entering C-ERIC, it is expected to be able to offer to users an extended set of synthesis/analytical techniques and increase the outreach to new users, as well as to gain fruitful interactions and cross-fertilization by exchange of expertise and of technical solutions. A specific aspect, given the mission of the Trieste institutions towards less favored Countries, is to enhance the possibilities for their scientists to test their ideas without having to overcome the barriers given by the lack of initial investments needed to have access to multiple instrumentation.

The "background environment" of the Laboratory/Institution hosting the proposed infrastructure, in view of the development of the best educational, technical training and industrial returns

General experience in EU and/or international collaborations and contracts

In the last two calendar years, 2010 and 2011 the contributions acquired through research contracts have amounted to about 3.2 million Euro in 2010 and about 2.3 million Euro in the first nine months of 2011. In the last year Elettra participated in 36 research contracts funded by the following external agencies: European Commission, European Science Foundation, Italian Ministry of Research, Italian Ministry of Economic Development, Italian Ministry of Foreign Affairs, Italian Association for Cancer Research, Regional Government of Friuli Venezia Giulia, International Centre for Theoretical Physics, Indian Department of Science and Technology. This has been possible on the basis of a very large number of collaborations with Institutions from Europe and at international level.

Publication record of in-house research

Elettra produces over 300 papers per year in international scientific journals. Publications are collected and archived on our database VUO (Virtual Unified Office). Focussing to papers published since 2001 and to papers in which at least one author is from Elettra (excluding papers produced by external users only), a bibliometric search on Scopus, gives more than 1550 papers with almost 12000 citations, 8 papers with about 100 or more citations, in fields spanning from life to nano sciences:

1. Hofmann, S., Sharma, R., Ducati, C., Du, G., Mattevi, C., Cepek, C., Cantoro, M., Pisana, S., Parvez, A., Cervantes-Sodi, F., Ferrari, A.C., Dunin-Borkowski, R., Lizzit, S., Petaccia, L., Goldoni, A., Robertson, J., *In situ observations of catalyst dynamics during surface-bound carbon nanotube nucleation*, Nano Letters **7** (2007) 602
2. Gimona, M., Djinovic-Carugo, K., Kranewitter, W.J., Winder, S.J., *Functional plasticity of CH domains*, FEBS Letters, **513** (2002) 98
3. Balog, R., ,Jørgensen, B., Nilsson, L., Andersen, M., Rienks, E., Bianchi, M., Fanetti, M., ,Lægsgaard, E., Baraldi, A., Lizzit, S., Sljivancanin, Z., Besenbacher, F., Hammer, B., Pedersen, T.G., Hofmann, P., ,Hornekær, L., *Bandgap opening in graphene induced by patterned hydrogen adsorption*, Nature Materials **9** (2010), 315
4. Goldoni, A., Larciprete, R., Petaccia, L., Lizzit, S., *Single-wall carbon nanotube interaction with gases: Sample contaminants and environmental monitoring*, Journal of the American Chemical Society **125** (2003), 11329
5. Djinovic-Carugo, K., Gautel, M., Ylänne, J., Young, P., *The spectrin repeat: A structural platform for cytoskeletal protein assemblies,* FEBS Letters **513** (2002), 119

6. Cossaro, A., Mazzarello, R., Rousseau, R., Casalis, L., Verdini, A., Kohlmeyer, A., Floreano, L., Scandolo, S., Morgante, A., Klein, M.L., Scoles, G., *X-ray diffraction and computation yield the structure of alkanethiols on gold(111)*, Science **321** (2008), 943
7. Mazzarello, R., Cossaro, A., Verdini, A., Rousseau, R., Casalis, L., Danisman, M.F., Floreano, L., Scandolo, S., Morgante, A., Scoles, G., *Structure of a CH_3S monolayer on Au(111) solved by the interplay between molecular dynamics calculations and diffraction measurements,* Physical Review Letters **98** (2007), 16102
8. Casalis, L., Danisman, M.F., Nickel, B., Bracco, G., Toccoli, T., Iannotta, S., Scoles, G., *Hyperthermal molecular beam deposition of highly ordered organic thin films*, Physical Review Letters **90** (2003), 206101

Other research, educational, industrial activities

Training and education programs in the application of synchrotron radiation and in the development and support of the complex, multi-faceted technology platform required to keep our facilities running are developed to ensure the growth of the new generation of scientists and technicians. This is also achieved by organizing and hosting conferences, workshops and scientific meetings, in particular involving potential users and different disciplines and research areas.

A continuous effort is also devoted to the industrial activities and to the technology transfer, this has been developed with the help of Industrial advisory panels and networks. The Industrial Liaison Office (ILO) promotes both the collaboration with industries and their use of the facilities, with a special care for SMEs. The skills and technical expertise resulting from the experience accumulated in the construction and operations of the Elettra facilities and in particular of the Free Electron Laser (FERMI@Elettra), recently commissioned, have contributed to the development of new devices and technologies whose exploitation is offered in support of industry R&D activities and other research Laboratories, as well as to generate new spin-off companies.

Support of the local authorities

Sincrotrone Trieste is supported by state funding as agreed between the Region Friuli Venezia Giulia and the Italian Ministry of Education, Universities and Research. The Regional Government has been particularly supporting the implementation of C-ERIC, having a particular Centre EU interest. A specific MOU between the Regional and the National Government makes reference to the support of this development.

Potential to influence and support the scientific and socioeconomic growth

Elettra has been the attractor and catalyzer of the development of a Research AREA (Science Park) starting from a green field. At present the AREA is the largest Technology-

Research Park in Italy, and hosts more than 60 Industrial Companies (some spin-offs from Elettra) and about 10 national and national Institutions, with a total staff in excess of 1500 people. The surrounding territory, hosting two small villages which were semi-isolated being outside main transit roads has been completely.

Previous experiences have been developed with the Central EU initiative, and with the local Universities, to stimulate the birth of industrial companies from research, involving successfully research ideas from the Centre EU Countries, and some spin-off Companies generated by Elettra's staff are now active also in the nearby Countries.

This expertise will be made available to C-ERIC, to help support and stimulate the growth of industrial and other socioeconomic aspects near all Partner Facilities.

Another aspect to be supported will be the involvement of schools and technical training. Building on the experience in Elettra and other Partners who are already actively working on these aspects, will allow strong synergies.

Additional services and amenities offered to the potential users

The Trieste and Friuli regions are well endowed with cultural, environmental and historical sites of very high quality. Visitors and in particular users have a wide choice of amenities and attractive aspects.

Limiting this to science and science-related aspects, the Trieste scientific environment includes world-level institutions such as the International Centre for Theoretical Physics and the International Centre for Genetic Engineering and Biotechnologies, both of which are operated under the aegis of the United Nations, the TASC laboratory of IOM-CNR, and the Consortium for Biomolecular Medicine (CBM). The users can profit from this environment which provides additional high-level facilities, and stimulating interactions.

Presentation of the C-ERIC proposed Partner Facility

The National Institute of Materials Physics (NIMP), Romania

Address: Atomistilor street no. 105 bis, Magurele, postal code 077125, Romania.

General presentation

The National Institute of Materials Physics (NIMP) is located in the campus of Magurele, at about 5 km from Bucharest. The campus is known also as the "City of Physics" in Romania. NIMP is developing basic and applied oriented research in the field of condensed matter physics and materials science. The focus is on advanced multifunctional materials and nanostructures with potential of applications in high-tech industries. The research interest has shifted from bulk single crystals and ceramics towards thin films, multilayers, heterostructures and nano-objects with various shapes. Among studied materials are those with semiconductor, superconductor, magnetic, dielectric, piezoelectric, ferroelectric, optic properties, either as single phase or in different combinations aimed to obtain new functionalities.

Details about research activities and the obtained results can be obtained from the annual reports (in English, see http://www.infim.ro/annual-reports.php).

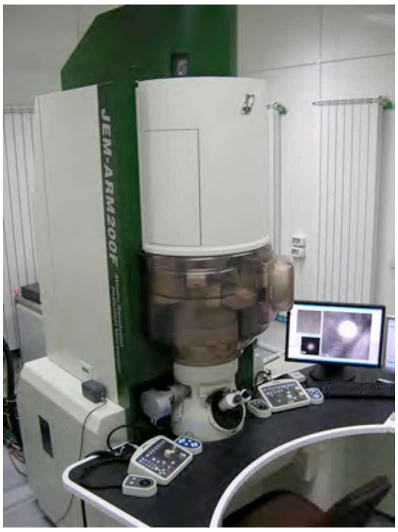
The research cycle comprises all the steps, from preparation/deposition, going through detailed investigation of structure, composition and physical properties, and ending with suggestions for applications (demonstrators).

NIMP as Romanian entry point

NIMP will act as entry point to C-ERIC through the ***Laboratory of Atomic Structures and Defects in Advanced Materials*** (LASDAM, see http://lab50.infim.ro/). The lab research activity concerns mainly the investigation of the the physical properties - mainly structure - in advanced materials, resulting either in size effects (nanostructures, thin films) or defect engineering. Although the size scale available through our investigation techniques spans from bulk to nanometric and atomic structures, our research is mainly directed towards the discovery, investigation and manipulation of physical properties at nanometric and atomic scale for the development and characterisation of new materials (dielectrics, semiconductors, alloys, ceramics) to be used in various applications (semiconductor technology, gas sensing, radiation detectors, telecommunications).

The instrumentation brought into C-ERIC

1. **High resolution TEM facility containing (see http://lab50.infim.ro/tem.htm):**



A newly acquired **JEOL JEM ARM 200F,** which is a Cs-corrected Analytical High-Resolution Transmission Electron Microscope. Principal details are listed below: *Configuration*: Field Emission Gun (FEG); Cs-corrector for STEM mode; STEM Unit; EDS Unit: JEOL JED-2300T; GIF (Gatan Image Filter): Gatan Quantum SE; CCD Cameras : wide angle: Gatan Orius 200D, bottom mounted: Gatan Ultrascan 1000XP, GIF camera: Gatan Ultrascan 1000FT. *Working modes*: CTEM, HRTEM, STEM BF, STEM ADF, STEM HAADF, SAED, nano-ED, CBED, EDS, EELS, EFTEM, EELS-SI. *Technical specifications*: Accelerating voltages: 80, 120, 160, 200 kV; TEM resolution: 0.19 nm; STEM-HAADF resolution: 0.08 nm; energy resolution EDS: 131,4 eV (Mn-Ka); EELS – energy resolution 0.7 eV.

A JEOL 200CX Analytical TEMSCAN microscope with EDS capabilities, able to operate with high resolution but only in the TEM mode. This one will be used for standard TEM investigations.

A fully equipped facility for the TEM specimens preparation**.**

2. **Electron Paramagnetic Resonance (EPR/ESR) facility (see http://lab50.infim.ro/esr.htm):**

It contains various types of EPR spectrometers, offering a full set of EPR investigations. The main equipment is the **Pulse/CW X-band ESR spectrometer model ELEXSYS E580 from Bruker with E560 DICE II pulse ENDOR and E580-400 pulse ELDOR accessories. Operating parameters : f**requency range (cw)-9.2 – 9.9 GHz; temperature-3.8 K $< T <$ 300 K; magnetic field-0.03 T $< B <$ 1.45 T; pulse resolution-1 ns; sensitivity-1.2 x 10^9 spins/Gauss; 1kW microwave power.

The Pulse ESR spectrometer can operate in several modes : FT-ESR; 2 and 3- pulse Electron Spin Echo Envelope Modulation (ESEEM); Hyperfine Sublevel Correlation (HYSCORE); Electron-Nuclear Double Resonance (ENDOR); Electron Double Resonance (ELDOR) (ELDOR detected NMR, DEER, Saturation Recovery ELDOR)

Other available ESR spectrometers:

CW Q-band ESR spectrometer model ELEXSYS E500Q from Bruker with E560 ENDOR accessory. Operating parameters: frequency-34 GHz; temperature-3.8 K < T < 300 K; magnetic field-0.03 T < B < 1.8 T; sensitivity-10^9 spins/Gauss; effective RF range-1- 250 MHz.

Jeol JES-ME-3X (X - and K - band). Operating parameters : frequency-9.45 GHz and 24 GHz; temperature-77 K < T < 570 K; magnetic field-10 mT < B < 1.5 T; sensitivity-5 x 10^{11} spins/Gauss; in-situ UV irradiation at variable temperature; heat treatment in controlled atmosphere.

Compact Microwave EPR Spectrometer CMS 8400

CW X-band ESR spectrometer model EMX-plus from Bruker (upgraded Varian E12)

Additional resources which will be made available to C-ERIC:

1. **Deposition equipments**

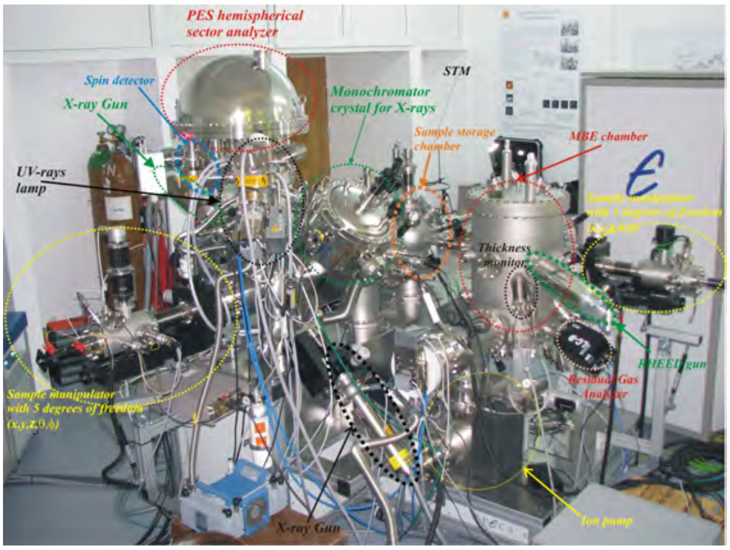
Pulsed Laser Deposition System - PLD for deposition of oxide materials thin films and multilayers, especially ferroelectrics and multiferroics. GAMMA 1000C™ advanced RF sputtering system_for depositing dielectric films. Chemistry and electrochemistry laboratories for preparation of nanostructures by template methods or self-aseembling.

2. **Micro and nanofabrication facilities**

Clean room with photolithography facility (Mask Aligner EVG 620 NT with NIL), electron beam lithography (SEM Hitachi S3400 with Raith EBL and Laser Interferometer positioning stage Raith), a dual beam system (SEM Tescan with FIB Brucker and characterization capabilities (EBD, EBSD)) and metallization equipments.

3. **Experimental Cluster for Surface and Interface Science**

The cluster is build around an MBE chamber, offering a variety of analysis techniques such as: STM, SARPES, XPS/UPS/ARUPS, RHEED, AES, LEED. The advantage is that the sample can be moved in UHV from one working station to another thus avoiding surface contamination.



A separate equipment is the PEEM (Photoemission Electron Microscopy) and LEEM (Low Energy Electron Microscopy) system. This can reach a lateral resolution of 4 nm in the LEEM mode, and of 15 nm in the PEEM mode.

4. **X-ray absorption fine structure spectrometer (Rigaku)**

It is an instrument allowing to performe some of the synchrotron type experiments such as EXAFS/XANES. Main characteristics: range of elements that may be investigated: from Ca to U; maximum power: 3 kW (maximum HV = 40 kV, maximum emission current 100 mA); interchangeable X-ray target: Mo, W; interchangeable filaments: W, LaB6; monochromating crystals: Ge(220), Ge(111), Ge(311), Ge(400), Ge(840), Si(400), Si(620).

The support staff for the infrastructure entering C-ERIC consists of:

- 14 senior researchers and 14 junior researchers, post-docs and PhD students
- 2 engineers and 4 technicians taking care of the research equipments, mainly: vacuum systems, cryogenic systems, mechanical parts, electronic components (just diagnose and small repairs)
- 1 engineers and 1 technicians in charge with the communication networks (phones, IT network)

Previous experience in “free open access” operation and/or established policy in “free open access” operation and evaluation mechanism of users impact;

NIMP has some experience regarding the “free open access” operation. In the framework of the national programmes one was dedicated to support the research infrastructures of national interests. In year 2003 NIMP was included in this programme with an XPS equipment (X-Ray and UV Photoelectron Spectrometer VG ESCA 3 MK II) which was at that time unique in Romania. Therefore, each year NIMP has received some money (between 50,000 and 100,000 euro) to cover all the expenses related to the operational costs. Instead, NIMP had to allow free access to any academia student or researcher willing to use the above mentioned equipment.

Existence of the ICT support infrastructure for data storage, handling and remote access;

NIMP has its own ICT infrastructure. All the equipments entering C-ERIC are computer controlled. There is also possibility for remote control and data transfer. After the establishment of C-ERIC NIMP will make available an SFTP server to store a copy of the data generated at each experimental system, so that users can access their data independently from the operational status of the experimental stations. The internet access is available at NIMP through two different lines, the transfer speed is 10 Mb/sec.

Potential complementarities

NIMP is offering to C-ERIC access to complementary analytical techniques, such as:

- HR-TEM investigation of nanostructures, thin films and interfaces; initially the facility will be dedicated to materials science, micro and nanoelectronic, optoelectronic applications based on inorganic compounds. HR-TEM facility can provide information about atomic structure, local composition, local strain/stress, defects, etc..Depending on future financial support, we plan to extend the facility to life sciences, adding an appropriate sample environment, which will make it an ideal complement to both X-Ray based (crystallography and SAXS) and NMR
- EPR spectroscopy, able to bring supplementary information regarding the local order, atomic forces and local physical properties providing that the sample contains paramagnetic impurities or defects which can be transformed in paramagnetic probes by charging with light or electric field.
- The surface physics cluster, with XPS/UPS, PEEM-LEEM and XAS equipments can complement the synchrotron facilities from Trieste (Elettra, Czech and Austrian beam-lines), providing services for less demanding samples and structures, or by offering preliminary information helping to asses if a sample worth to be subject of more in depth characterization by using synchrotron radiation, saving in this way beam time and lowering the costs.

NIMP brings also expertise in some fabrication techniques which can be of interest for C-ERIC potential users:

- Nanotubes/nanowires synthesis by combination of template method with electrochemistry
- Thin film deposition by PLD, MBE and magnetron sputtering

- Self-assembling methods (for nanoparticles or nano-dots)
- Micro and nano fabrication in clean room environment

In conclusion, NIMP has strong complementarities with the other infrastructures which will be part of C-ERIC. On one hand NIMP is providing facilities for preparation/growth of samples (thin films, nanostructured materials, nano-objects), facilities which are not present to other infrastructures. On the other hand NIMP is offering access to analytical facilities (HR-TEM, EPR spectroscopy) which complements the facilities offered by the other partners (e.g. the Elettra synchrotron from Trieste/Italy, the NMR centre from Slovenia, the Neutron Centre from Hungary and the beam lines for SAXS and MSB from Austria and Czech Republic).

The "background environment"

The annual turnover for NIMP was of about 10 millions euro in the last 4 years. Most part of the funds is from national and international projects. About 2 % of the funds are from economic activities with private companies. NIMP has an excellent research infrastructure and a highly qualified research staff. Presently, NIMP has about 150 researchers among which 108 held a PhD degree and 25 are PhD students.

General experience in EU and/or international collaborations and contracts

NIMP has experience in European collaborations being partner in many projects funded by European Commission (FP programs, Euratom, COST), or funded by other third parties (EUROCORE, SCOPES, NATO). NIMP was partner also projects lead by CERN (RD48-Research and development on silicon for future experiments, together with other 39 research institutions from all over the world-see http://rd48.web.cern.ch/rd48/; RD50-Radiation hard semiconductor devices for very high luminosity colliders, together with other 46 research institutions-see http://rd50.web.cern.ch/rd50/). A total of about 45 international projects and bilateral collaborations were funded in the last 5 years. NIMP has ongoing collaborations, based on agreements, with over 40 research institutions in Europe. Main "collaborating" countries are Germany, Italy, France, UK, Spain, the Netherlands, Belgium, Switzerland, Norway, Greece. More details can be found in the annual reports (in English, see http://www.infim.ro/index.php, button "Publications").

Publication records of in-house research

NIMP has also a good record in publications. An average of about 160 articles per year was published in the last 4 years in ISI journals. Some other publications were on conference proceedings, books chapters and journals which are not indexed on Web of Science (e.g. some 50 papers in 2010 and some 100 in 2011). In the last three years an average of about 15 % of the publications were in journals with impact factor over 3, and about 35 % were in journals with impact factor over 2. The list of publications can be found at http://www.infim.ro/papers.php.

NIMP is also filling patent applications, with an average of 3-4 patents per year. However, the patents are only at national level.

Other research educational, industrial activities

NIMP is developing some educational activities in collaboration with the Faculty of Physics in Bucharest. Master students and PhD students are working at NIMP. Some of the NIMP's senior researchers are also PhD supervisors and teach classes at the Faculty of Physics. Some 20-30 master and PhD students are working every year at NIMP, and other 5-10 are employed every year with fixed term contracts on funded projects.

NIMP offers services to private companies, some of them multinationals as Zentiva, Honeywell and Oerlikon. A number of Romanian SME's were involved in common research projects in the frame of the Partnership program.

Other elements

NIMP is among the first 3 Romanian institutes developing research in Physics. This fact is recognized by the national ranking up-dated by the Ad-Astra association (see http://www.ad-astra.ro/cartea-alba/?lang=en). NIMP is also involved in some other very important projects supported by the National Authority for Scientific Research:

- The foundation of a category II UNESCO centre as part of NIMP. This will be dedicated to advanced training and studies in physics.
- The construction of the third pillar of ELI (Extreme Light Infrastructure), called ELI-Nuclear Physics (ELI-NP).

Other amenities in Magurele: a 2 star hotel; a guest house belonging to the Faculty of Physics, which can be also accessed by NIMP at request; a shopping centre for basic needs; several restaurants; public and private transportation to Bucharest city (maximum 40 minutes to the city centre during the day).

Presentation of the C-ERIC Partner Facility

Slovenian NMR Centre

Address: Slovenian NMR Centre, National Institute of Chemistry, Hajdrihova 19, SI-1000 Ljubljana, Slovenia

Web-page: www.nmr.ki.si

Quality and the potential of the facility to support excellent science at the cutting edge, and offer a service to external users

The Slovenian NMR centre was established by the Ministry of Science and Technology, Slovenia in November 1992 as a national research infrastructure unit. Since its establishment it offers support to other researchers and is thus strongly and actively involved in scientific endeavours in Slovenia and abroad. Within the last decennia its research scope has been growing constantly and the centre has been opening to international community. The clear ambition is to develop the capacities in the coming years to become facility of international standards that will offer access to the users in the region of Central Europe and elsewhere. Annual research program of Slovenian NMR Centre is approved by the Scientific council. NMR measurements are performed within and with collaboration with over 70 research projects (the list is available at www.nmr.ki.si/research_publications/research_publications.html). Notably, over 20% of those projects involve international collaboration within FP7 projects, COST actions and bilateral projects with various EU countries and other countries (e.g. Turkey, USA). Several partners of the facility acquire and interpret their data themselves. On the other hand, a large number of users perform their studies in collaboration with Slovenian NMR centre. The results are published in around 40 papers annually in well-respected international scientific journals (the list is available at www.nmr.ki.si/research_publications/research_publications.html). Apart from scientific objectives NMR centre is closely involved in projects connected to R&D work in the local industry, especially with pharmaceutical companies.

The results of the Slovenian NMR centre place us among the top groups in Slovenia. Internationally, we are a recognized member of the scientific community. Noteworthy, we were the first and only EU Centre of Excellence in Slovenia under the framework of FP5. Keeping the high standards of scientific quality, international collaboration and constant upgrades in infrastructure coupled with the growth in expertise and capacity have been our incentives for years. Slovenian NMR centre is currently offering access to its international users on a per-review base within the framework of two FP7 projects (i.e. EAST-NMR and BioNMR).

The Slovenian NMR centre offers expertise as well as instrument access to users that study relationships between structure, sequence of biomolecules, dynamics and molecular recognition in order to gain deeper insights into biological functions, chemical structures and interactions in solution or solid phase as well as into the nature of fundamental processes that contribute to understanding of important biological processes or properties of chemical entities and materials. Slovenian NMR centre also offers support to the development and production processes in the pharmaceutical, chemical, petrochemical, agrochemical and food industry. NMR spectroscopy is indispensable in chemical analysis and identification, determination of 3D structures and studies of dynamics of small and larger bio-macro-molecules, following of chemical reactions, in analytical and bioanalytical procedures, identification of metabolites, identification of various amorphous forms, and the study of polycrystallinity. Our expertise is widely used in the production of coatings, paints and plastics, as well as being an analytical tool for inorganic and organic materials. It is also used for environmental protection purposes and in establishing the provenance and quality of food products.

The specific topics covered could be categorized under the following research activities:
(1) structural studies of biological macromolecules such as proteins and nucleic acids, and their dynamics in solution state,
(2) studies towards understanding of molecular basis of diseases,
(3) structure characterization and interaction of novel biologically active compounds with protein targets, design of active compounds,

(4) structure and interactions in the solid-state, polycrystallinity and polymorphism,

(5) characterization of recombinant proteins in solution,

(6) structure and analysis of synthesised lower molecular weight compounds in solution and solid-state, and

(7) study of complex mixtures of compounds in solution - profile of impurities in drugs, degradation products, quali- and quantitative analysis of organic compounds with the use of hyphenated techniques.

An important aspect of the operation of our centre is its educational role. The NMR centre educates researchers for the implementation of NMR experiments and interpretation of NMR spectra at the concrete structural problems in the context of the undergraduate diplomas, Master degrees and Ph.Ds.

Type and quality of the instrumentation

The current instrumentation includes an 800 MHz, two 600 MHz (one paid for and to be installed during 2012) and two 300 MHz NMR spectrometers with a broad selection of probes including cryo probes. More information about the equipment at the Slovenian NMR centre can be found at http://www.nmr.ki.si/instruments.html.

In recent years the centre has undergone a major upgrade of the instrumentation. With the 800 MHz spectrometer and its 1H and 13C-enhanced cryo probe and the new 600 MHz spectrometer it is possible to record spectra on smaller sample quantities or acquire spectra on dilute samples and in a shorter time. The new 1.6 mm T3 probe for recording spectra of solid-state samples allows faster spinning up to 45 kHz and higher power of decoupling that are important for obtaining spectra of higher resolution.

With the start of C-ERIC and the strong support given to us by our Government, we hope to be able to further improve our present high quality and bring our instrumentation to the cutting edge at the European and global levels. Recently the first 1 GHz NMR spectrometer has been installed at RALF-NMR facility in Lyon, France. High-field spectrometer of such quality allow important increase in terms of spectral resolution and sensitivity. It will be possible to study intrinsically unstructured proteins, which are structurally disordered and/or proteins with limited solubility. Additionally, we envisage increase in our capacities in the field of solid-state NMR by investment into a high-field wide bore magnet (such as 850 MHz). It should be possible to utilize new equipment in studies of materials covering a broad temperature ranges and nuclei of low gyromagnetic ratio. Currently solid-state NMR is used in studies of porous materials (micro- and mesoporous silicates, alumino-phosphates, metal-organic frameworks) and ex-situ measurements of charging/discharging of batteries (6Li NMR spectra offer insight into structural characteristics). Our vision is to utilize solid-state NMR spectroscopy also in structural biology problems (e.g. amyloid deposits, membrane proteins). Upgrades of instrumentation will follow the specific demands of users of our facility. We will search for complementariness that NMR can offer to other methodologies available within C-ERIC.

Availability of adequate support staff

The team of Slovenian NMR centre consists of several senior researchers that are experts in solution and solid state NMR of proteins, nucleic acids and small molecules. Expertise to setup NMR experiments and process acquired data is provided to users of facility by a team, which currently consists of 1 full Professor, 1 Associate and 2 Assistant Professors, 2 senior researchers, and a number of students (currently 5 PhD students). Two technicians and an engineer maintain and assist in operating NMR spectrometers and sample preparation. Support offered to users within C-ERIC will include protein expression, isotopic labeling and purification that will be supervised by 1 full Professor and 3 senior researchers.

Smooth running of the user access to effectively allocate spectrometer time to diverse problems of structure characterization requires careful coordination. The access to specific high-field NMR spectrometer involves also an administrative support (arrival and departure of users, room reservation, etc.). Our users are supported by an experienced team of scientists and engineers that offer help in performing their studies. Supervision and assistance by the local staff enables assistance in data acquisition and interpretation of multidimensional NMR spectra as well as computer modeling leading to preparation of joint publication. The instrument scientists are available on site to solve experimental problems.

Visitors also benefit from the scientific environment of National Institute of Chemistry where spectrometers and NMR center are located. It is an environment of vivid and high-level scientific activity. The institute hosts 17 laboratories with broad range of expertise ranging from molecular modeling, synthetic organic chemistry and analytical chemistry to polymer chemistry, biotechnology, molecular biology, electron microscopy and several spectroscopic techniques including mass and vibrational (IR and Raman) spectroscopies. The users perform their experiments in a multi-disciplinary environment, which stimulates cooperation and cross-fertilization; users can easily have contacts with scientists in various fields from computational chemistry to molecular biology.

Availability of appropriate logistical laboratory environment

The Slovenian NMR centre has been up and running since 1995. Appropriate laboratory set-up to enable operation of high-field NMR spectrometers including the adjacent 'wet-labs' for fine tuning of sample preparation are available. The facilities to process acquired NMR spectra are available. The NMR centre is integrated in the logistical environment of National Institute of Chemistry and has therefore access to its supporting facilities. Specific procedures of procurement, storage and handling of consumables have been introduced. Special and hazardous substances are tracked and handled appropriately.

Protein expression, isotopic labelling and purification will be also possible within the Laboratory of Biosynthesis and Biotransformation. Protein expression is routinely performed in E. coli, P. pastoris and insect cells. Novel non-uniform labelling schemes such as 19F selective labelling of tryptophan or tyrosine amino-acid residues are available and enable studies of more complex structural biology problems. Molecular interaction analysis will include Surface plasmon resonance (Biacore T100, GE Healthcare, Biacore X), Isothermal calorimetry (VP-ITC, MicroCal, GE Healthcare) and Stopped-flow fluorescence (SX20 Stopped-Flow, Applied Photophysics).

Previous experience in "free open access" operation

All spectrometers in our centre as well as the team of experts have been opened to support all interested users for over 15 years. Slovenian NMR centre operates under the guidance and evaluation of The Scientific Council that reviews its program and results. An online reservation system is in place that enables booking of spectrometer time on the 800 MHz and 600 MHz NMR spectrometers. The system enables transparent use of spectrometer time and offers advance planning to users. Open access operation is available through the portals of two I3 project, namely EAST-NMR (www.east-nmr.eu) and BioNMR (www.bio-nmr.net). Within these two projects Slovenian NMR centre offers transnational access to its spectrometers to external users outside Slovenia whose project are evaluated favourably by the International evaluation panel (ca. 20% of spectrometer time under 24-7 regime is used).

Existence of the ICT support infrastructure

The Slovenian NMR centre is an organization unit of the National Institute of Chemistry, Ljubljana, Slovenia (www.ki.si) which offers all the technical support and necessary equipment for data storage and processing. The data security is well taken care of and all NMR spectrometers are behind the firewall. All computers are connected with gigabit Ethernet connections. Every spectrometer contributed as a Partner Facility has a dedicated host computer with access to internet. Data storage and backup is being done locally and a secure VPN access is granted to users for remote data recovery. Users can access their data independently from the operational status of the experimental stations. Procedures for remote access to the facilities are currently available through the portals of two I3 project, namely EAST-NMR (www.east-nmr.eu) and BioNMR (www.bio-nmr.net). Within these projects Slovenian NMR centre offers transnational access to its spectrometers in a transparent and peer-reviewed system.

Perceived organization and institutional ability to provide the services proposed act as national reference point to outreach the scientific and technical communities

The NMR centre has been conceived as a national facility and has served as a model of organization of research infrastructure since. Links to complementary methodologies have been developed and are lively. Slovenian NMR centre has the organization and institutional capacity to provide the services proposed and act as national reference point to outreach the scientific and technical communities.

Potential complementarities to other proposed Partner Facilities, in the perspective in offering integrated analytical/synthesis capabilities in view of current and future research topics

Previous experience in European networks

The Centre was nominated an EU Centre of Excellence under FP5 in 2000. This project and activities have enabled to better integrate into the international community and to expand capacities in terms of hardware and personnel as well as advance in our scientific potential and scope. Currently Slovenian NMR centre is a partner in two European Commission's projects within the framework of FP7, EAST-NMR and Bio-NMR.

EAST-NMR - Enhancing Access and Services to East European users Towards an efficient and coordinated Pan-European pool of NMR capacities to enable global collaborative research & boost technological advancements (www.east-nmr.eu) is a project that provides transnational access to NMR instrumentation based in Eastern Europe and provides access to solid-state NMR facilities at the international level. It educates and trains researchers, especially from Eastern Europe, in NMR's potential and use. It also advances in sample preparation technologies especially difficult to tackle membrane proteins through joint research activities. Slovenian NMR centre is one of the four centres in geographically Eastern Europe that offers access to spectrometers. In the first three years of duration of EAST-NMR project we hosted users from Northern Ireland, Great Britain, Hungary, Germany, Italy, Croatia, Poland and Slovakia and offered them help in acquisition and interpretation of NMR data. Approximately 15% of spectrometer time has been used within the above Transnational access scheme, where each of the 15 project from users outside Slovenia has been reviewed by the International evaluation panel. Importantly, links between Slovenian NMR centre and top NMR facilities in Europe (e.g. Florence, Frankfurt, Utrecht, Lyon and Birmingham) as well as partners in Brno, Warsaw and Debrecen have been strengthened. Best practices in providing access to NMR spectrometers are being exchanged. The results of Joint Research Activities from all 21 partners of the consortium are being transferred to facilities offering access and are therefore made available to external users also at Slovenian NMR centre.

Bio-NMR project (http://www.bio-nmr.net) aims to further the structuring of the Biological NMR infrastructures, their user community and biological NMR research in Europe into a coherent research community prepared to tackle scientific and biomedical challenges of increasing complexity at the forefront of research worldwide. The project involves a comprehensive group of top NMR research infrastructures providing access in Europe and related stakeholders. Slovenian NMR centre is one of the eleven centres that offer access to spectrometers within the BioNMR project. In the first 18 months of duration of the project we hosted users from Northern Ireland and Poland and offered them help in acquisition and interpretation of NMR data. Approximately 20% of spectrometer time will be offered within the transnational access arrangement. The potential user from outside Slovenia applies for NMR spectrometer time with a project that is reviewed by the International evaluation panel. The links between Slovenian NMR centre and top NMR facilities in Europe (e.g. Florence, Frankfurt, Utrecht, Lyon, Zurich, Berlin, Oxford, Birmingham, Gothenburg and Brno) lead to exchange of best practices in providing access to NMR spectrometers. The results of Joint Research Activities from all 19 partners of the consortium are being transferred to facilities offering access and are therefore made available to external users also at Slovenian NMR centre.

Previous experience in multiple analytical/synthesis techniques

The Centre offers expertise as well as instrument access to users that apply NMR spectroscopy in their research. Although NMR spectroscopy is indispensable in chemical analysis and identification, determination of 3D structures and dynamics of small and larger bio-macro-molecules, following of chemical reactions, in analytical and bioanalytical procedures, identification of metabolites, identification of various amorphous forms, etc the importance of the use and integration of complementary techniques has been established. In 2009 the centre has coordinated the project proposal and the setting-up of the EN-FIST centre of excellence (www.enfist.si) where methods such as vibrational spectroscopy, X-ray diffraction techniques, mass spectroscopy, chromatographic separation techniques, various microscopies, including computational support are combined into an integrated initiative. Activities of EN-FIST have been financed with the budget of 10 million euros for four years and will contribute to upgrading of NMR facilities at Slovenian NMR centre.

Expected outcome and added value of entering in the C-ERIC

The Slovenian NMR centre will contribute NMR expertise and access to modern spectrometers, which will complement and strengthen activities in the fields of structural biology and materials. The C-ERIC is composed of leading scientific centres, which represent the most powerful methods to characterize the structure of advanced materials, namely, synchrotron and conventional X-ray scattering and imaging, neutron scattering, solid- and solution-state NMR spectroscopy and electron microscopy. These techniques are widely used in studies of physical and chemical properties of materials as well as the characterization of synthetic and biological materials and processes. Each of these techniques provides important and often complementary information about the system under investigation. It is the ambition and goal of the facilities involved in C-ERIC to combine different experimental methodologies and offer users possibility of multidisciplinary studies employing complementary techniques.

High-resolution NMR spectroscopy allows characterization of ordered and disordered materials at different length- and time-scales through the observation of the different nuclei present in the samples. Providing both structural and dynamic information, this technique has become a unique tool for the characterization of materials and their synthesis routes. Solid-state NMR providing local information about details in the structure is highly complementary to scattering experiments yielding global structural information. Solution-state NMR spectra will enable studies of proteins and other biomolecules that are hard to crystalize. Structural biology utilizing NMR data can address properties of biomolecules that do not adopt a well-defined 3D structure per-se. The intrinsically unstructured proteins play a great importance in molecular events of our Life and understanding of their properties can aid in design of drugs for major diseases of today (e.g. neurodegeneration in aged human). In addition, NMR studies offer insight into dynamic phenomena that are difficult to be analysed by other methods. The timescales covered range from rotation of small group in a molecule within nano-seconds to events on a much longer scale (seconds to hours or longer). Knowledge from NMR studies will represent an important complement to structural biology projects that have been successfully running at ELETTRA.

We strongly believe that by entering the C-ERIC our research infrastructure will serve as a platform for cooperation between research institutes, universities and industrial partners in Europe, and play an important role in solving challenges of present and future. With our instruments and expertise we can add a significant value to European research area.

The "background environment" of the Laboratory/Institution hosting the proposed infrastructure, in view of the development of the best educational, technical training and industrial returns

General experience in EU and/or international collaborations and contracts

The Slovenian NMR centre is a partner in different international collaborations since its establishment in 1992. In 2012 seventeen international projects (list available at www.nmr.ki.si/research_publications/research/Research2011_SLONMR.pdf) involve the use of our NMR facility in their studies. The researchers of Slovenian NMR centre are partners in several bilateral projects with researchers from a number of European countries. Importantly, since 2009 Slovenian NMR Centre is a partner in EAST-NMR and since 2010 in Bio-NMR EU FP7 projects.

Publication record of in-house research

Results and achievements, which are the result of cooperation of Slovenian NMR centre with laboratories and groups around Slovenia and abroad are annually published in around 40-50 publications in journals with international peer review evaluation procedure (detailed list is available at www.nmr.ki.si/research_publications/research_publications.html). Several of the publications are published in journals which are at the top of the respective scientific fields. Staff of the centre annually exchanges visits with several institutions around the world and presents results in the form of seminars as well as lectures at international conferences.

Other research, educational, industrial activities

An important aspect of the NMR Centre's activity is its role in education. The centre offers help at collection and interpretation of NMR spectra on specific structural problems that are part of bachelor, master and doctoral thesis. Annually several students complete their undergraduate education with a research project performed within Slovenian NMR centre. Staff of the centre supervises Ph.D. students. The NMR centre participates in the Erasmus program and is also a partner and host facility within IAESTE student exchange program.

The Centre plays a role of infrastructural facility and as such offers its support and expertise in the field of NMR spectroscopy to all interested academic research institutions as well as to commercial companies. There are several industrial partners that use our services and expertise of our NMR facility. Annually around 25% of spectrometer time is allocated and used for industrial projects.

Slovenian NMR centre is strongly integrated with R&D in the local industrial partners. Noteworthy, five industrial partners (Krka, Lek, Helios, Sava and Donit) were the founding partners of the centre and invested considerable amounts of funds to purchase modern NMR spectrometers. The close cooperation of Slovenian NMR centre with the founding industrial partners and other industrial partners in the region contribute to the socioeconomic growth of the region of SE Europe.

Support of the local authorities

Slovenian NMR centre was established by the national Ministry of Science and Technology in 1992 and has a broad support of national scientific authorities including Slovenian Research Agency, and the Ministries of Health and Agriculture. Long term support of industrial partners has been vital to make operation of research equipment sustainable. Operation of the facility is supported nationally by a long term grant that covers costs of maintenance and consumables.

Potential to influence and support the scientific and socioeconomic growth

Slovenian NMR centre is performing an advanced characterization and is offering expertise to the industrial companies in the region as for example: advanced structural characterization of small organic compounds and their interactions in drug formulations for pharmaceutical companies or protein structure determination. Contacts and preliminary studies on aptamers have been performed with a start-up company IPB. We are willing to cooperate with companies that are and will be part of the Technology park of Ljubljana (ca. 5 km away from the location of NMR center).

Additional services and amenities offered to the potential users

The NMR centre has been constantly growing in terms of scientific quality, hardware, capacity and is nowadays able to not only offer access to research equipment that operates at international standards, but also contribute in shaping specific projects. As described above a 'wet-lab' and expertise is available to express, isolate and purify proteins and other biomacromolecules in addition to the tuning of NMR sample.

The centre is within walking distance to the city center of Ljubljana. Cultural life is very active, especially in summer when several festivals and open air concerts are being organized. Ljubljana itself, being a pre-Roman town offers very interesting historic sites. Short term visitors are typically accommodated in the hotels that are few minute walk away from the NMR centre. Longer term visitors can stay at furnished flats owned by the National Institute of Chemistry or dormitories of University of Ljubljana that can be rented for a well affordable price.

Annex 2: Terms of Reference and composition of the International Evaluation Committee (I-EvCo)

Terms of Reference for the evaluation of the CERIC Partner Facilities

Background:

C-ERIC is a Distributed Research Infrastructure[1] set-up by connecting and integrating one Partner Facility in each participating Country. C-ERIC will be able to attract researchers at world level , by the overall quality and complementarity of its Partner Facilities , offering them a unique capability to perform analytical and/or synthetic procedures on a wide range of different materials down to atomic size and time dimensions (nanometers and femtoseconds).

The first inclusion of the Partner Facilities in the C-ERIC will be based on proposals[2] put forward by the Governmental Parties to C-ERIC (in the following "Parties"), which, before acceptance, will be evaluated by an independent International Evaluation Committee (EvCO) composed by high level experts.

EvCo will act as an Advisor to the C-ERIC Working Group, who has been charged by the Parties of the first setting-up of C-ERIC.

Objectives for the International Evaluation Committee (EvCo)

The main objective of the EvCo is that of ensuring that the most appropriate Partner Facilities are inserted in the C-ERIC, in its start-up phase.

This includes:

Definition of steps, procedures and evaluation criteria to implement the evaluation[3].

Definition of a reference structure/questionnaire for the proposals to be submitted.

Evaluation of the proposals forwarded by the Parties.

Report on the evaluation to the C-ERIC Working Group, indicating acceptability and/or suggestions for amended/improved proposals.

Final report, with possible comments/suggestions on the strategic outlook for C-ERIC in the starting phase.

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[1] Defined according to the ESFRI criteria

[2] According to the draft Statute the PF is one for Country and will act in international partnership as single national reference point to stimulate and support the access and the outreach to researchers and technicians as well as their international training and benchmarking. The proposals for Partner Facilities which will be put forward by the Parties and refer also to facilities or parts of facilities already set-up in other Parties (e.g. beamlines and/or measuring stations), which will be operated as an in kind contributions to the common scope of the C-ERIC. Possible examples of facilities expected to be proposed are analytical facilities as NMR, neutron, synchrotron and/or FEL beamlines and measuring stations, electron microscopes, integrated nanoscience and nanosynthesis laboratories, materials preparation support laboratories (e.g. for biocristallography, cultural heritage), etc.

[3] An indicative set of questions and criteria is in Annex1

The above process must ensure both the excellence of, and the synergy between, all Partner Facilities, to achieve the best quality of the scientific services offered, thus fulfilling the mission of C-ERIC. The process should allow, if necessary, for iterations between the proposing Parties and the EvCo, to reach a shared decision and/or develop perspective strategies for future improvements.

Creation of the EvCo:

The EvCo is set up by the C-ERIC working Group, by first nominating a Chair and then the components of the EvCo in consultation with the Chair, based on the expertise needed to cover the proposals.

Considering the above, the C-ERIC Working Group, in its meeting in Prague on December 18 2011, has decided to set-up the EvCo, and nominate its Chair, to support the process of setting-up C-ERIC.

The C-ERIC Working Group has also decided to proceed, with the help of the EvCo Chair, to the definition of the questionnaire and criteria to be required from the proposing Parties.

Activities, timing and method of working

The timing for completing the evaluation procedure for a first set of at least three Partner facilities in three Member Countries (the minimum required to set-up C-ERIC) should be within the first half of 2012, to allow the proposal of C-ERIC to move forward.

The EvCo will complete its mandate when all proposals received by the Parties have been evaluated, or as soon as the General Assembly of the C-ERIC will set-up the C-ERIC's International Scientific and Technical Advisory Committee (ISTAC) who will advise on the strategies as well as verify the quality of the Participating Partner Facilities in the longer term. The ISTAC will take-over the process initiated by the EvCo pursuing it further to ensure growth of quality and scientific impact of C-ERIC.

The evaluation of the proposals will be based on the documents provided by them and/or, if deemed necessary, by further queries, site visits and/or interviews.

Resources to support EvCo activities

A secretarial support to EvCo will be given by the secretariat of the C-ERIC working Group. Financial and organizational support for travel and subsistence of the members of EvCo will be provided through the secretariat operating at Sincrotrone Trieste.

ANNEX 1[4]

An indicative list of questions and evaluation criteria is the following:

- The quality and the potential of the facility to support excellent science at the cutting edge, and offer a service to external users. This may require evaluating:
    - The quality of the instruments
    - The availability of adequate support staff
    - The availability of the appropriate logistical laboratory environment
    - Previous experience in "open access" operation or established policy in "open access" operation and evaluation mechanism of users impact
    - Existence of the ICT support infrastructure for data transmission, storage, curation and future access
    - The perceived organizational and institutional ability to provide the services proposed and to act as national reference point to outreach the scientific and technical communities.
- The potential complementarity to other proposed Partner Facilities, in the perspective in offering integrated analytical/synthesis capabilities in view of current and future research topics. This may require the evaluation of:
    - Previous experience in European networks
    - Previous experience in multiple analytical/synthesis techniques
- The "background environment" of the Laboratory/Institution hosting the proposed infrastructure, in view of the development of the best educational, technical training and industrial returns, this may require the evaluation of:
    - General experience in EU and/or international collaborations and contracts
    - The publication record (contents, numbers and quality) of in-house research
    - List of other research, educational, industrial activities in easily connected surroundings.
- An assessment of other elements as, e.g.:
    - Support and future strategies expressed by the local authorities
    - Potential to influence and support the scientific and socioeconomic growth
    - The completeness of the responses
    - Additional services and amenities offered to the potential users.

[4] Based on ESFRI experience

Composition of the International Evaluation Committee (EvCo)

- **Christian Vettier**, former scientific director of ILL and of ESS (neutron specialist)
- **Cécile Hébert**, from EPFL (microscopy specialist)
- **Annalisa Pastore**, from MRC-UK (NMR specialist)
- **Ingolf Lindau,** from Stanford and Lund (synchrotron specialist)
- **Denis Raoux,** former director of synchrotron SOLEIL (synchrotron and magnetism specialist)
- **Luis Fonseca,** from CSIC in Barcelona (nanoscience and nanomaterial specialist)
- **Michel van der Rest**, former director of synchrotron SOLEIL and former chair of ERF (life sciences specialist)

Annex 3: Report of the International Evaluation Committee (I-EvCo) to the C-ERIC working group

Final report of the International Evaluation Committee (I-EvCo) to the C-ERIC working group

May 16, 2012

Members of the I-EvCo : Annalisa Pastore, Cécile Hébert, Ingolf Lindau, Luis Fonseca, Christian Vettier, Denis Raoux, Michel van der Rest (chair)

Context of the evaluation

The members of the I-EvCo have been nominated by the C-ERIC working group in consultation with the selected chair of the committee. A first round of evaluation was made on preliminary documents handed to the committee at the beginning of March 2012. In order to help the working group in the preparation of the proposal, an interim report was prepared and handed to the working group in the middle of March. It was also presented orally by the chair of I-EvCo to members of the working group present at the ICRI2012 conference in Copenhagen on the 22d of March. This was an opportunity for the chair of I-EvCo to exchange with some of the partners on the objectives, the means and the difficulties for setting up C-ERIC.

A final draft of the proposal was handed to the I-EvCo members on April 18th. In depth analysis of the proposal was made and this report summarizes the general comments from the members. A separate document detailing specific comments and suggestion for further improvement has been handed to the partners.

Analysis of the proposal

The document readily conveys the idea of setting up a pan-European distributed infrastructure made of existing facilities in Central and East European countries devoted to open access in the field of analysis and synthesis for advanced materials and life sciences. This research infrastructure will constitute a single legal entity operated with a single governance scheme offering free and open access under a common access point and evaluation procedure to international proposals based only on scientific merit provided they require a multi-technique approach that exploits the technological offer of C-ERIC.

The synergies enabled by the C-ERIC were not yet fully apparent in the initial documents received by I-EvCo in March. The final draft of the proposal has been a tremendous clarification on these issues and the partners have to be congratulated for the quality of their work which shows that a solid basis does exist for setting up the consortium. In particular, all the partners clearly mentioned the expected outcome and the added value of entering in the C-ERIC as well as the complementarities between their individual scientific programs and technical capacities. Most of them also indicate how they would contribute to C-ERIC and make use of their available resources to fulfill their obligations. Though there are different levels of maturity and achievements, it is the unanimous advice of the members of I-EvCo that the proposal is mature enough to be supported at the present stage.

There have been some changes in the contour of C-ERIC between the March document and the April final version. These evolutions have been very positively appreciated by I-EvCo, in particular the inclusion of the Budapest Neutron Center and the Institute of Biophysics and Nanosystems (IBN) at Graz (Austrian beamline on synchrotron ELETTRA). The decision to wait for the concretization of the Polish SOLARIS synchrotron project for its inclusion in the consortium has been considered wise, but it was also noted that this project is extremely structuring for Central Europe science and has clearly its place in C-ERIC when the facility will become operational.

The scientific and technical description of C-ERIC clearly defines the consortium as a single distributed facility integrating the various partner facilities under common governance, with a unique access portal for the users whatever the facility they apply for. Beyond the access to facilities not available at a national level, the long term perspective is clearly in line with some better integration of the national science policies in Central Europe and with the nucleation of a single scientific community.

This goes well beyond the level of cooperation usually achieved between partners in I3's and other similar EU cooperative programs. It will imply to define suitable governance rules and practices, beyond those commonly in use in EU programs.

I-EvCo wants to underline to the partners that they must expect to face scientific and technical challenges (how to run a single portal with a single selection committee? how to help the users in developing multitechnique projects at different places? how to be more efficient than the sum of the individual partners?) as well as political ones.

The major difficulty will undoubtedly be to secure the required resources, in particular human resources. The analysis of individual facilities by I-EvCo has indeed revealed that several of these are at the lower limit in terms of staff for their current operation. The extra activities brought by C-ERIC are going to create a burden to the personnel that can only be met by proper resource allocation.

Another difficulty will undoubtedly be that overall the facilities cover quite different areas of scientific expertise with little overlap in some cases (e.g. between a center dedicated to material sciences and another one dedicated to life sciences). It will be of great importance that efforts and means be dedicated within the C-ERIC to develop effective and practical interactions between all facilities, taking full advantage of the evident complementarities that are present.

It is however the opinion of I-EvCo that, on the basis of the strategy described in the final application these potential difficulties can be overcome and that it will be only by practical experience and exposure to concrete problems that workable solutions will be found.

Advice of the committee

The unanimous and strong advice of I-EvCo is therefore to go ahead with the creation of C-ERIC which will constitute a unique and novel opportunity to foster outstanding science in Central Europe.