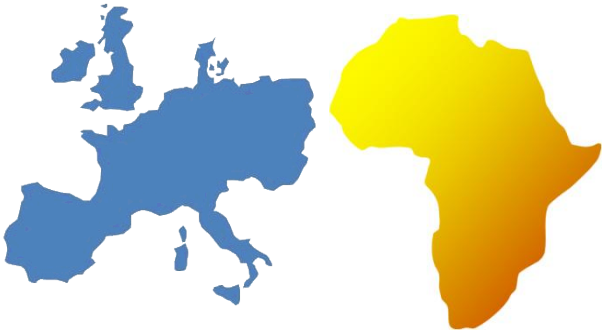
PAERIP

Promoting African European Research Infrastructure Partnerships



Considerations for African-European partnerships in Research Infrastructure

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1 Introduction

This document describes considerations for African-European partnerships in Research Infrastructure (RI). It covers research infrastructure that are part of the ESFRI (European Strategy Forum on Research Infrastructures) roadmap and those that are not part of this roadmap to develop an understanding of partnerships between the two continents.

This study is based on a previous report[1] which identifies Research Infrastructure on both continents which have a high potential for international collaboration. An inventory[2] is available on the PAERIP website (www.paerip.org). The objective of compiling the inventory was to determine which European RI may have relevance to and hence the potential of contributing to Africa's continental science and technology priorities and also benefit from African participation. The intention was to be very inclusive in the inventory and to paint a landscape of possibilities. The current report focuses on case studies that are selected based on primarily European RI leaders that volunteered to respond to a survey and then only those that expressed themselves on questions relating to whether partnerships with African RI could potentially expedite the implementation of European RI and secondly, whether it is believed that RI initiated in Europe or distributed RI in a specific domain, could be housed in Africa and why.

Two views are thus offered: the potential Africa has to contribute to the implementation of the ESFRI roadmap and the potential Africa has to host European RI, also as part of global partnerships. The concept of partnerships in the context of RI is also addressed.

1.1 The European RI landscape

At European level ESFRI has been instrumental in consolidating a roadmap for RI. In 2001, the Council of Ministers recognised that policy making on research infrastructures of European significance has steadily become more complex and less effective and that a more collective approach was needed to guide policies related to RI. This directly led to the creation of ESFRI in 2002, with the mandate to support policy-making on research infrastructures, both existing and new, in Europe.

ESFRI brings together representatives of EU Member States and Associated Countries and of the European Commission. The first ESFRI roadmap, published in 2006, included 35 projects. It was updated in 2008 and 2010 and currently lists 48 research infrastructures, covering scientific areas such as: Social Science and Humanities (5 projects), Environmental Sciences (10 projects), Biomedical and Life Sciences (10 projects), Energy (4 projects), Physical Sciences and Engineering (8 projects), Materials and Analytical Facilities (6 projects) and e-Infrastructures (1 project).

The whole process is helping to prioritise the existing and new research infrastructures and to pool resources at European level. In addition, ESFRI is also stimulating international cooperation to ensure that the full scientific and educational potential is used by the Member States and Associated Countries, recognising that some of the ESFRI research infrastructures are already global in their nature.

There are also numerous RI in Europe that is not part of the ESFRI roadmap. Opportunities for African-European cooperation on these RI are also examined in detail in the next sections.

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[1] *An Inventory of African and European Research Infrastructure that could support potential Partnerships between the two Continents and Access Mechanisms to Research Infrastructure*, A P Botha, G von Gruenewaldt and T C Botha, May 2012 Version 1.0, Report of the PAERIP (Promoting African European Research Infrastructure Partnerships) Project, Grant Number: 262 493

[2] Database developed by the National Documentation Centre (EKT) and National Hellenic Research Foundation (NHRF) in Greece.

1.2 The African RI landscape

While Africa's S&T priorities are articulated in many documents that are endorsed at senior levels, the focus of the PAERIP project was to consider those priorities articulated in two particular documents:1) the indicative projects of the S&T programme clusters listed in Africa's Science and Technology Consolidated Plan of Action (CPA) - adopted by the African Union and the New Partnership for Africa's Development (NEPAD); and 2) the projects listed in the so-called "Book of Lighthouse Projects", agreed between the European Commission and the African Union Commission in October 2008, as a set of tangible targets for the practical implementation of the 8th partnership of the 2007 Joint Africa-EU strategy.

The PAERIP inventory that was compiled for African research infrastructure, focused on RI that could be of specific interest to European researchers to access. The inventory was compiled through consultations regarding research infrastructure cooperation needs with some leading African research programme managers and science and technology representatives from bodies such as the NEPAD Planning and Coordinating Agency and the International Council for Science (ICSU) Regional Office for Africa.

The RI taken up in the inventory are primarily those which address priorities in the Consolidated Plan of Action but others are also included such as those with a e.g. geographical advantage perspective, such as astronomy. In most cases RI in Africa were identified that could have *potential impact* on the CPA and Book of Lighthouse Projects and should not be understood to be declared associated RI.

Identifying RI in Africa to include in the inventory was complicated by the fact that there are no national, regional or continental roadmaps similar to ESFRI for the African continent. This lack of a continental register of RI results in a fragmented view of what RI exists and what RI is required for the future.

Africa has, however, well developed RI in areas such as the physical and natural sciences, particularly in nuclear, materials and laser research, biological research, oceanography, astronomy, health, environmental remote sensing, water research, agriculture (including natural products) and energy. The diversity in social structures and languages contribute to an active social sciences research area in Africa, leading to RI in human language technologies.

Knowledge networks present a popular form of RI in Africa and the exploration of indigenous knowledge is an active research environment. Unique collections, sample and data repositories and biobanks occur all over the continent. A major initiative throughout Africa is to establish e-infrastructures that support the connectivity of RI and researchers.

1.3 What are RI partnerships?

The PAERIP Project is in essence an initiative 'Promoting African European Research Infrastructure *Partnerships*'. The notion of a RI partnership has to be clarified before recommendations can be made on promoting such partnerships.

The previous PAERIP report referred to above commented on access to research infrastructure. Access is totally different from a partnership, although a partnership could also allow for certain access rules. Partnerships are forged in unique circumstances where all parties involved in the partnership benefit from the agreement. The necessary condition is thus mutual benefit.

Partnerships are shaped by considerations that lead to a country investing in particular RI, either in the conceptualisation, co-planning, development, operation and management along the RI life cycle and not merely using it by way of agreement and at an agreed cost.

Priority areas for RI investment and development are chosen for several reasons[3]:

- The need for national and regional competitiveness
- A country or region having geographic advantage
- Countries with 'problem' advantages, such as unique patterns of diseases
- Knowledge advantage based on traditional or indigenous knowledge or long exposure to industrial specialisation

A new realisation on a global scale that some scientific issues are just too large for one or a few countries to address has led to the notion of global RI.

RI partnerships at a global or intercontinental scale are developing because of:

- The need to harness collective global knowledge and experience
- Leveraging new international funding for RI
- Promoting access between RI
- Facilitation of the mobility of researchers
- Assisting in addressing global challenges

RI partnerships are facilitated and strengthened by the advent of better communication and connectivity and data sharing. This has been made possible by:

- Integration and networking between existing RI
- Collaborative feasibility studies and design work for large RI
- High speed broadband communication networks, cloud data sharing and grid computing
- A willingness towards joint investment

In an effort to describe a RI partnership, it should be considered that different parties play a role in the planning, establishment and use of RI. These include governments, research institutions, higher education institutions, researchers and industry. Partnerships between and among them will differ, depending on the purpose of the partnership.

Governments may enter into agreements to jointly fund and develop RI or establish bi- or multi-lateral agreements on the use of RI, the funding of researchers to travel to the RI and the support of the scientific projects undertaken.

Research societies may also agree to pursue a common goal for developing or accessing specific RI in the interest of advancing the professions or disciplines represented by the society.

At institutional level a partnership may allude to an agreement for access and use of the RI and the support of researchers to travel and use the facilities.

At peer level, a partnership is most often based on common interest in a particular field of science and collaborative research, which may include the mere use of RI or the actual development of a component of the RI relating to a specific experiment. This may lead to researchers using RI elsewhere, whilst it may be available at their own institutions or in their own countries.

Given this background understanding of what shapes a RI partnership, PAERIP adopts the following description for a RI partnership:

A Research Infrastructure (RI) partnership is an agreement between governments, research societies, research institutions, higher education institutions or individual researchers or groups of researchers to jointly plan, invest, develop, construct, manage, use and phase out RI that holds mutual benefit in terms of advancing the frontiers of knowledge, enables research on intercontinental or global challenges, provides access to science that holds geographic or regional knowledge advantage and contributes directly or indirectly to national competitiveness.

[3] R Adam, Comparative advantages and global research infrastructure partnerships, http://www.nottingham.ac.uk/ecriuk/presentations/pdf_files/Adam.pdf

1.4 Features of a successful RI partnership

Since this is the first effort of its kind to consider the nature of RI partnerships between Europe and Africa, some criteria have to be developed to assist in a decision to qualify a potentially successful partnership in the PAERIP context. Considered at a very high level, such a partnership must ideally:

- Provide clear mutual added value and benefit
- Deliver top-level research opportunities and services attracting a widely diversified international community of scientific users
- Uphold scientific excellence
- Ideally address global challenges and have a large potential impact on how they manifest in Africa and Europe
- Provide some of the essential tools for the growth and alignment of the African and European research areas
- Demonstrate continuous improvement of the underlying e-infrastructure and supporting knowledge infrastructure, allowing data acquisition, transfer and analysis, as well as data conservation and administration, to make both data and infrastructure easily accessible to scientists

2 The global environment for the development of new international RI

Global challenges are important drivers for research and innovation. The planet has finite resources which need to be cared for sustainability; climate change and infection diseases do not stop at national borders, food security needs to be ensured across the globe.

Research challenges are increasingly interlinked internationally, aided by rapidly developing information and communication technologies. The number of internationally co-authored scientific publications and the mobility of researchers are increasing. Research organisations are establishing offices abroad and companies are investing outside their home countries, in particular in the emerging economies.

Global RI is required to support such research and innovation. This RI is often of the nature of being single-sited, distributed or consists of national RI of global interest. Nonetheless, such global RI requires an effort that reaches over disciplines, policy environments, politics and economies. To succeed in defining and realising these global RI, a common framework is required. This common framework should speak to scientists, policy makers, users, industry and other RI owners. At the first G8 Ministerial meeting (Okinawa 2008), it was decided to form a Group of Senior Officials (GSO) to take stock and explore cooperation on Global Research Infrastructures[4]. It should propose by the end of 2012 a draft framework for international cooperation in the field of Global Research Infrastructures.

The success of establishing global RI also depends on the growing trend from national authorities to coordinate their activities on RI with other entities and governments in cases where large, expensive RI of a global nature is established, e.g. SKA as an ESFRI project and the governments of South Africa and Australia. For this very reason, PAERIP can play a major role in creating an awareness and providing guidelines for RI partnerships between Europe and Africa that would also become platforms for global RI. A common framework will require a thorough identification of areas of cooperation and the need to agree on general principles. These are also the foundation for RI partnerships as contemplated in the PAERIP context.

To succeed, global RI and RI partnerships require a clear decision making process, prioritisation that is understood by all parties, ways to deal with collaborative funding and arising funding issues, innovative management of complex joint development and procurement environments, governance of RI, access agreements, and life cycle

[4]Gonzalo León, Perspectives from GSO – International cooperation on global research infrastructures, PAERIP Workshop, Cape Town, South Africa, 11 November 2011

management, including phasing in, controlling peak use and retiring ageing RI.

3 Policy frameworks – are they supporting partnerships?

This section outlines the policy frameworks that exist in Europe and in Africa at continental level to promote the international collaboration of their Research Infrastructures.

3.1 EU Policy framework

At European level, Framework Programmes for Research and Innovation have been instrumental in supporting transnational collaborative research and technological development. The current Seventh Framework Programme (FP7) comes to an end in 2013 and will have operated to an overall budget of €50.5 billion. FP7 placed a new emphasis on international research cooperation by mainstreaming it across the entire spectrum of FP7 activities. It also included strategic activities underpinning the building of a European research area open to the world, that require a policy dialogue with major regions of the world, and true partnership with those countries with which an S&T Cooperation Agreement has been signed.

FP7 has specialised funds for RI. The overall objective of the 'research infrastructures' part of the FP7 Capacities programme is to optimise the use and development of the best research infrastructures existing in Europe[5]. Furthermore, it aims to help to create new research infrastructures of pan-European interest in all fields of science and technology. The European scientific community needs these to remain at the forefront of the advancement of research, and they will help industry to strengthen its base of knowledge and technological know-how. The funds can be applied to support existing research infrastructures, support new research infrastructures, and support policy development and programme implementation.

The 8th Framework Programme, entitled Horizon 2020 (2014-2020) will, for the first time, provide a set of common objectives based on the Europe 2020 strategy and the related Digital Agenda for Europe and Innovation Union initiatives across funding for research and innovation. One of the most relevant features of Horizon 2020 is the objective of strengthening international cooperation with third countries (non-EU countries). Horizon 2020 sets the goal of increasing the Union's excellence and attractiveness in research to tackle global challenges jointly, supporting the Union's external policies and contributing to the achievement of the Millennium Development Goals. The emphasis on international cooperation with third countries may create many new opportunities for European-African research infrastructure cooperation and partnership formation.

To enhance and focus the approach of international cooperation, in September 2012, the Commission adopted a Communication[6], proposing a new strategy for developing international cooperation actions. The new strategic approach will be characterised, inter alia, by Horizon 2020 being fully open to third country participants, and developing multi-annual roadmaps for cooperation with key partner countries and regions, including developing countries. Such roadmaps will contribute to the sustainable development of these regions and address challenges such as the green economy, climate action, improved agriculture, food security and health. This includes supporting the Millennium Development Goals, and their possible successors, as well as strengthening demand-led research and innovation for development.

To drive forward international cooperation in research and innovation, the Strategic Forum for International Science and Technology

[5] http://cordis.europa.eu/fp7/capacities/research-infrastructures_en.html

[6] COM(2012) 497

Cooperation (SFIC) was established in 2008. SFIC is a dedicated configuration of the Scientific and Technical Research Committee of the Council of the European Union (CREST), composed of high-level representatives of the Member States and the European Commission, with countries associated to the 7th Framework Programme having an observer status. Its objective is to facilitate the further development, implementation and monitoring of the international dimension of ERA (European Research Area). In practice, this means sharing information and consultation between the partners (Member States and the Commission) with a view to identifying common priorities which could lead to coordinated or joint initiatives. The group also aims at coordinating activities and positions *vis-à-vis* third countries and within international fora. SFIC is today developing three pilot initiatives: the China Pilot Initiative, the India Pilot Initiative and the USA Pilot Initiative. SFIC will continue the initiation of new activities, and Africa is a candidate for the new initiative.

ESFRI recognised that existing legal forms under national law do not fulfil the needs of new pan-European research infrastructures[7]. ESFRI subsequently identified a need to develop a dedicated Community legal framework for setting-up European research infrastructures involving several member states. This legal form is called a European Research Infrastructure Consortium (ERIC). The new legal framework is designed to facilitate the joint establishment and operation of research facilities of European interest among several member states and countries associated to the Community R&D Framework Programme, and to help develop further the European policy for research infrastructures. It is thus a governance and coordination body for the RI. Only member states, third countries and intergovernmental organisations can be members of an ERIC. However, a state may decide to be represented by one or more public entities or private entities with a public-service mission, e.g. research organisations or research councils. An ERIC is a sign of recognition by governments and the European Commission of the importance of sharing RI. It remains the responsibility of a member state, however, to own and support the RI.

Policy frameworks regarding structural and regional funds, investment bank funds and private equity for research infrastructure are considered, but not well developed at present.

In short, the EU landscape for research and RIs is undergoing dynamic changes. But this welcome trend is yet to bring improvement in supporting European-African partnerships.

3.2 African Policy framework

The African Science and Technology Consolidated Plan of Action (CPA) is one of the science and technology initiatives on the African continent. It strives to unite science and technology programmes of the African Union (AU) Commission and the New Partnership for Africa's Development (NEPAD). While it does not mention research infrastructure for Africa, the plan puts emphasis on developing an African system of research and technological innovation by establishing networks of centres of excellence dedicated to specific R&D and capacity building programmes.

It is seen as a framework against which RI could be defined, developed and utilised to support the outcomes of the CPA. Although the CPA is not addressing RI directly, its implicit value to achieving the pan-African goals contained in the CPA has been paramount in the structuring of the PAERIP inventory and suggested linkages with European RI that could lead to partnerships.

The CPA outlines as research priorities the following areas:

- Conservation and sustainable use of biodiversity
- Safe development and application of biotechnology

[7] http://ec.europa.eu/research/infrastructures/index_en.cfm?pg=eric3

- Securing and using Africa's indigenous knowledge base
- Building a sustainable energy base
- Secure and sustainable water
- Combating drought and desertification
- Building Africa's capacity for material sciences
- Building engineering capacity for manufacturing
- Strengthening the African Laser Centre
- Technologies to reduce post-harvest food loss
- Information and communication technologies
- Establishing the African Institute of Space Science
- Establishing an African Science, Technology and Innovation Indicators Initiative
- Improving regional cooperation in science and technology
- Building public understanding of science and technology
- Building science and technology policy capacity
- Promoting the creation of technology parks

From discussions with NEPAD officials it would seem as if in future overall science and technology policy directions and guidelines for Africa will be the responsibility of the AU Directorate for Human Resources, Science and Technology, whereas any continent wide development of programmes aligned to such policy guidelines will be undertaken by NEPAD.

Activities of a more regional nature or interest are usually coordinated by NEPAD on the basis of Regional Economic Communities such as the Southern African Development Community (SADC), Economic Community of West African States (ECOWAS), Community of Sahel-Saharan States (CEN-SAD), East African Community (EAC), Economic Community of Central African States (ECCAS/CEEAC), etc.

Agreements between African countries and the European Community exist for participation in the Framework programmes. For example, the European Union and South Africa have concluded an agreement already in 1997 on scientific and technological cooperation which complements the Trade, Development and Cooperation Agreement (TDCA) on aspects of science and technology that are crucial for economic and social development. Cooperation takes place in areas of mutual interest and for mutual benefit in using, in particular, the European Framework Programmes as a vehicle for cooperation.

4 Opportunities for African partners to support the implementation of the ESFRI Roadmap

In order to investigate the potential of RI partnerships between Africa and Europe, PAERIP has relied on its inventory of European and African Research Infrastructure, face-to-face surveys and interviews with representatives of RI in Europe and Africa, an online survey on the PAERIP website and meetings with policy makers in Europe and Africa.

Two perspectives were investigated:

- African partners to participate in the development and implementation of research infrastructures envisioned in the ESFRI Roadmap
- African potential to host European research infrastructures, also as part of global partnerships

A few case studies are now presented to illustrate how such partnerships (existing or future) may be structured and applied.

4.1 Opportunities for African partners to participate in the research infrastructures envisioned in the ESFRI roadmap

In an analysis following a survey amongst European RI of the awareness of ESFRI projects in their planning and design phases about possible needs for African researchers to utilise the RI, the outcome was that very little, if any consideration was given to needs

of African researchers in the majority of the projects. However, as these projects enter the implementation phase, a realisation is emerging on how some of them could partner with African researchers or RI. Opportunities do, however, exist as pointed out in the case studies that follow to involve African RI and researchers to ensure successful implementation of the ESFRI roadmap.

The few case studies given here highlight special circumstances where potential or existing collaboration could contribute towards better implementation of the ESFRI roadmap. In each case the question should be considered of how a *formal RI partnership* could strengthen such impact? It should be borne in mind that such partnerships may be between two RI based on joint use or between organisations or entities which jointly develop RI. The reader is referred to the PAERIP inventory for details about the institutions (and their acronyms) mentioned here. The role of case studies in this report is to *gain an understanding* of the state of collaboration or cooperation and how they can be firmed up into partnerships. This knowledge gained through PAERIP could then be applied by the entities funding research to promote, encourage and advocate the formation of partnerships between them and the RI.

4.1.1 BBMRI

The inventory developed by the PAERIP team indicates several potential collaborative environments between African RI and European RI. One of the first indicators of success of such collaboration that may lead to formal partnerships is where the African RI represents an extension of data which may at present be regional and unique to the European RI. A good example of this is in biobanks where specimens from Africa may complement the European collections.

A case at hand is the European Biobanking and Biomolecular Resources Research Infrastructure (BBMRI) for which implementation is envisaged before the end of 2012. BBMRI states the following[8] on opportunities for global collaboration, and thus potentially collaboration with African biobanks:

> 'New threats to health have emerged, such as pandemics as well as problems related to climate change and demographic changes that place pressure on the sustainability and viability of health care systems. These challenges can only be addressed efficiently by scientific evidence-based solutions developed in a globally coordinated manner. Human biological samples, such as blood, tissues or DNA including associated medical data are key resources in unravelling genetic and environmental factors causing diseases and influencing their outcome. Revealing the molecular basis of diseases will depend critically on the availability of well-documented, high quality biological samples from large numbers of patients and healthy persons, collected and made available by biobanks.'

The OECD Global Biological Resource Centres Network (GBRCN) should provide an international framework to sustainably provide access to biological samples and biomolecular resources in a quality controlled and secure manner. In Europe, the pan-European BBMRI implement the OECD best practice guidelines for biological resource centres and will become the European part of a human-domain GBRCN. The planning phase of BBMRI has been completed in 2011 and involved more than 270 institutions from 33 countries. Although no African countries are mentioned on the BBMRI list of associated organisations, the PAERIP inventory indicates the possible collaboration with at least four RI that host biobanks in Africa, two of which focus on human tissue, being the European, Middle Eastern and African Society for Bioprevention and Biobanking as a network run from France and the Institute for Human Virology in Nigeria. BBMRI will now be implemented by EU Member States under the

[8] K. Zatloukal, Institute of Pathology, Medical University of Graz, Austria

international European Research Infrastructure Consortium (ERIC) legal entity and should start its operation in 2013. BBMRI-ERIC will comprise existing and newly established collections of all types of human biological samples including associated data, biomolecular resources (e.g., antibodies, gene clone collections, cell lines and model organisms), biobanking and analytical technologies, data management solutions as well as ethical and legal services. BBMRI-ERIC is designed to improve efficacy and reduced costs of high quality research collaborations in all fields of medical research. In order to facilitate international collaboration BBMRI developed the concept of expert centres that are linked to biobanks and perform the sample analysis under internationally standardised conditions. BBMRI expert centres commit to implementation of common quality management schemes, share reference materials, and participate in proficiency testing. This facilitates data integration from multinational studies thereby allowing sample analysis in the country of origin and avoiding the need of transnational sample shipment. Furthermore, the establishment of expert centres in the context of biological resource centres will be instrumental in transforming key natural resources into knowledge and innovation.

According to information on the AU web pages discussions between officials of the Human Resources, Science and Technology section of the AU and BBMRI have taken place quite recently on the aims and objectives of the pan-European BBMRI and that further discussions regarding African involvement in the activities of BBMRI are contemplated. In this regard it is also of interest to note that two African countries, viz. Kenya and Gabon, are already partners of the GBRCN.

4.1.2 FAIR

An international accelerator facility, known as the Facility for Antiproton and Ion Research (FAIR), has been established in Darmstadt, Germany. The FAIR facility consists of a carefully designed configuration of interlinked machines for accelerating and storing high-quality particle beams, and creating new particles by colliding or bombarding the beams on targets for a wide range of experiments. The basis of the facility will explore advanced research in accelerator technology and equipped with unprecedented beam intensity, will perform experiments in the areas of nuclear physics, high energy physics, hadron physics, atomic and plasma physics. The RI will be built in cooperation with an international community of countries and scientists.

FAIR will truly be an international facility with participation from more than 10 countries in the initial phase. Once in operation, it will be a host laboratory for basic research for about 3000 scientists from about 50 countries. African researchers are highly welcome. African researchers can participate as both users and consortium members. In order to receive access to the RI, African scientists have to submit a proposal which is evaluated on the basis of its scientific merit. If it meets FAIR's criteria, scientists receive access to the RI. With the research infrastructure still in a phase of genesis, the questions as to whether it will be subject to the payment of a small fee or not is still a matter for negotiation.

African researchers can also become members of the FAIR consortium. The possibilities are:

- To become shareholders and co-owners of the RI following an investment of €12 million into setting up the facility
- To become associate members following an investment of € 5 million
- Join one of the four large collaborations and provide the RI with equipment (e.g. detector, electronics etc.) and receive the beam time in return

FAIR's management structure is a unique feature. Participating countries will be shareholders in the FAIR-GmbH. This structure of management is radically different from CERN where only the European countries are member states and non-European countries can only have an observer status.

FAIR's scientific community is actively trying to get African scientists on board by both developing an open access policy to the RI as well as by providing advice, recommendations and support to African science community on the development of their organisational structure (FAIR encourages the creation of the African equivalent of the Nuclear Physics European Collaboration Committee NuPECC). A complex science-community structure will facilitate broader participation in FAIR.

Working in international collaborations offers unique opportunities for R&D and may open doors to a new quality of science on both continents. European-African research collaboration would facilitate the knowledge transfer between the two regions; contribute to the training of the best scientists in all disciplines including physicists, chemists, materials scientists and engineers. It will also contribute to the training of students, who will have the opportunity to work in all research areas, participating in instrument development during the construction phase- and in experiments right at the frontiers of discovery once FAIR is commissioned. They will have the opportunity to take advantage of tutelage from world-class researchers working in a highly creative international atmosphere.

4.1.3 ESFR upgrade

Africa has been debating the acquisition of a synchrotron for a long time. This is probably an ambition that will still take a long time to realise. In South Africa, the creation of the SRRIC (Synchrotron Research Roadmap Implementation Committee) has led to consideration of a continental synchrotron, but the roadmap points towards continued use of European synchrotrons such as the ESFR (ESFRI) and ELETTRA and SOLEIL (non-ESFRI) for a considerable time. This may include continued and enhanced use of the upgrade of the most powerful high energy synchrotron light source in Europe (Grenoble, France), which brings together a wide range of disciplines including physics, chemistry and materials science as well as biology, medicine, geophysics and archaeology. The potential for setting up dedicated beam lines for users from Africa is also contemplated. Individual researchers from institutions in Morocco, Tunisia, Kenya and South Africa already use the ESFR.

4.1.4 LifeWatch

Another example where African data could contribute to the strengthening of an ESFRI project is LifeWatch which is expected to be implemented before the end of 2012. LifeWatch will construct and bring into operation the facilities, hardware, software and governance structures for all aspects of biodiversity research. It will consist of facilities for data generation and processing; a network of observatories; facilities for data integration and interoperability; virtual laboratories offering a range of analytical and modelling tools; and a service centre providing special services for scientific and policy users, including training and research opportunities for young scientists. The infrastructure has the support of all major European biodiversity research networks. SANBI is a complementary facility in South Africa and there is existing collaboration between LifeWatch and SANBI. Although the LifeWatch web site does not list any other African country as a participant, it could largely benefit from collaboration with similar organisations on the African continent to gain access to data that is not available in Europe and that may be crucial to providing a holistic view to conserving, utilising and managing biodiversity. The PAERIP inventory lists the following as possible African collaborators: SAEON (South African Environmental Observatory Network), B&ES (South African Environmental Observatory Network), BIOTAAfrica (Biodiversity Monitoring Transect Analysis in Africa), DMC (Drought Monitoring Centre), REWU (Regional Early Warning Unit),ICPAC (IGAD Climate Prediction and Applications Centre), AGRHYMET (Centre Regional de Formation et d'Application en Agrométéorologie et Hydrologie Opérationnelle), MAB (UNESCO Man and Biosphere Programme), WASCAL (West African Science Service Centre on Climate Change and Adapted Land Us) and GMES

(Global Monitoring for Environment and Security Africa) Africa.

4.1.5 EPOS

An African RI that could contribute largely to an ESFRI project is AfricaArray. EPOS, as an ESFRI project, has been implemented as an integrated solid Earth Sciences research infrastructure. EPOS is a long-term integration plan of national existing RIs and includes data and observatories on earthquakes, volcanoes, surface dynamics and tectonics. The goal of EPOS is to promote and make possible innovative approaches for a better understanding of the physical processes controlling earthquakes, volcanic eruptions, unrest episodes and tsunamis as well as those driving tectonics and earth surface dynamics. EPOS will be an open access infrastructure. Several thousand researchers in the Earth sciences will benefit from the services provided and this will foster major advances in the understanding of the dynamic processes occurring in the Earth.

AfricaArray has been established to ensure highly trained African geoscientists and researchers are available for Africa. This is motivated by the fact that geoscience professionals are key to sustainable development, especially as demand grows for natural resources from Africa under the influence of global change. Already in place for eight years, AfricaArray refers to scientists working on arrays of continent-wide linked projects; arrays of shared training programmes and observational networks; and above all, a common vision that Africa will build and retain capacity in an array of technical and scientific fields. Apart from addressing human capacity development in the geosciences, AfricaArray also promotes geophysical research and has designed and established a network of geophysical observatories consisting of seismic stations. Data from this observation network is archived in IRIS (Incorporated Research Institutions for Seismology) funded by the National Science Foundation (NSF) in the USA. Central to AfricaArray are partnerships. AfricaArray grew out of a partnership of three organisations—the University of the Witwatersrand (Johannesburg, South Africa); the Council for Geoscience, (Pretoria, South Africa); and the Pennsylvania State University (University Park, PA, USA). EPOS could also benefit by collaborating with the Aon Benfield Natural Hazard Centre at the University of Pretoria in South Africa.

This case study illustrates that there are well developed RI in the form of physical instrumentation and knowledge centres on the African continent that has been developed with other partners than Europe. An equivalent networked RI environment exists in Europe. By exploring the possibilities of also partnering with each other, the research area could be strengthened on both continents and a major contribution could be made to global understanding of geophysical events and induced risk, with its resultant socio-economic advantages to communities and local economies.

4.1.6 CLARIN

Existing collaboration between Africa and Europe in the social sciences takes place through CLARIN which is expected to be fully implanted by the end of 2012. The CLARIN project is a large-scale pan-European collaborative effort to create, coordinate and make language resources and technology available and readily useable for the whole European Humanities (and Social Sciences) community. CLARIN will be built on and contribute to a number of key technologies coming from the major initiatives advancing the eScience paradigm, such as data grid technology to connect the repositories as being implemented in the DAM-LR pilot project and web services the various centres provide; digital library to create live archives; semantic web technology to overcome the structural and semantic encoding problems and advanced multi-lingual language processing technology that supports cultural and linguistic integration. CLARIN is already collaborating with HLT (Human Language Technologies) of the Meraka Institute and CTexT of Northwest University in South Africa. CLARIN is supported by a non-ESFRI

project DASHISH (Data Service Initiative for Social Science and Humanities). The fact that European languages have been adopted by many countries in Africa and influence indigenous languages, and at the same time are being influenced by those same African languages, could mean that CLARIN could be largely enriched by linking strongly to its African counterparts, which it has started to do. The complexity of the co-existence of languages and the formation of new words under influence of other languages can be better understood by exploring the uniqueness of poetry, lyrics, literature and local metaphor present a rich natural laboratory for linguistics, the lexicon and grammar. Repositories of speech, dialect, stories and literature form an extended reference base. Human language technologies and the use of vernacular in human-machine interfaces is an emerging field on both continents. It has a large impact on education and training and in cross-border trade and negotiations and automatic translation and machine translation, all of which point to a common environment between Europe and Africa in terms of being multilingual continents where states are very dependent on neighbour states for trading, national security, food security, conservation of the environment and tourism.

4.1.7 ELIXIR

ELIXIR will be a secure, rapidly evolving platform for collection, storage, annotation, validation, dissemination and utilisation of biological data when implemented by the end of 2012. It will comprise a distributed and interlinked collection of core and specialised biological data resources. The core resources will include a substantial upgrade to the existing molecular data resources at the European Molecular Biology Laboratory's European Bioinformatics Institute (EMBL-EBI), as well as new resources as appropriate. The specialised resources will be distributed across several sites in Europe hosted by centres of excellence (the 'ELIXIR Nodes') and connected to a central hub (the 'ELIXIR Hub') located at EMBL-EBI in Hinxton, UK. ELIXIR will also include the necessary major upgrade to the computer infrastructure to store and organise this data in a way suitable for rapid search and access, and will provide a sophisticated but user friendly portal for users. Additionally, it will provide the infrastructure necessary to utilise data in a manner that is most appropriate for users of other research infrastructures in biological and medical sciences and environmental sciences.

Future collaboration between Europe and Africa through ELIXIR could be established on many levels[9] and will be actively encouraged by ELIXIR. In the coming years, once ELIXIR is fully established in Europe, partners will look to expand membership to include international countries, including several in Africa. African Member States could help to structure their bioinformatics capacities by becoming a member of ELIXIR. At a scientific level, institutes in Africa could participate in the infrastructure by hosting an 'ELIXIR Node'. These nodes are centres of excellence distributed throughout the participating countries, offering a degree of expertise in one or more of the following: data provision (e.g. biological, agricultural or medical data), computing provision, tools, training or standards.

There will be opportunities for staff from African nations to work for ELIXIR. As an example, EMBL-EBI, the coordinating institute for the ELIXIR preparatory phase, already employs staff from Africa (South Africa, Nigeria, Zimbabwe, Egypt and Zambia). Such exposure to RI was also promoted in previous PAERIP workshops as very beneficial in gaining an exchange in not only the use of RI but also in the planning, development and management of RI.

Researchers throughout Africa will also be able to use ELIXIR as a repository of data, thus ensuring that the biological data generated on their research projects is maximised and used to develop further knowledge and understanding.

[9] Prof Janet Thornton

The data provided through ELIXIR will be critical in helping to solve some of the world's Global Challenges, such as managing the health of an ageing population, infectious diseases, climate change and the security of food supply, challenges which are particularly important for many African countries.

The Human Heredity and Health in Africa (H^3Africa) initiative aims to inject significant sums of money into Africa from the NIH and Wellcome Trust for research into genetic and environmental factors relating to human health. Funding of a Pan-African Bioinformatics network may be considered. Several million US dollars have been set aside for the development of bioinformatics in Africa to support H^3Africa projects. This development will include training and collaborations with international organisations, such as the ELIXIR hub, EMBL-EBI and the result will be improved bioinformatics capacity and infrastructure on the continent. Skills in the analysis of human genetics (including GWAS and NGS data) will be developed and valuable genetic and phenotype data will be generated, thus putting African countries in a much better position to contribute to, benefit from and work with ELIXIR.

Successful collaboration is the key to the effective operation of research infrastructures. In the field of ELIXIR, many institutes in Africa will hold data that is of interest to life sciences researchers globally. Facilitating this collaboration in the field of bioinformatics between Europe and Africa will be made easier by using national and transnational networks of bioinformatics providers, such as the African Society for Bioinformatics and Computational Biology, and the soon to be implemented H^3ABioNet, which links over 20 Bioinformatics groups from 14 African countries, as a starting point for collaboration. Funding should be coming soon via H^3ABioNet for bioinformatics capacity development in Africa and training courses, which include participation of trainers from ELIXIR.

4.1.8 EISCAT_3D

EISCAT_3D will be a three-dimensional imaging radar for atmospheric and geo-space research, which constitutes an upgrade to EISCAT, an existing international infrastructure based in Europe and devoted to the study of the upper atmosphere, ionosphere and geospace. Implementation is expected by the end of 2012. EISCAT_3D will consist of multiple phased arrays, using state-of-the-art signal processing and beam-forming techniques to achieve ten times higher temporal and spatial resolution than available from present radars. EISCAT_3D will be designed for continuous operation, capable of imaging an extended spatial area over northern Scandinavia with multiple beams, interferometric capabilities for small-scale imaging and with real time access to the extensive data. The new design will greatly extend EISCAT data coverage and provide unique volumetric and small-scale imaging capabilities. It will also allow major improvements in temporal and spatial resolution, as well as producing new data products.

EISCAT_3D is a development project of the EISCAT Scientific Association, whose headquarters are located in Kiruna, Sweden. The consortium consists of 8 partner institutions from 5 countries including Sweden, Norway, Finland, the UK and Belgium. Three additional countries are participating in research activities. Several countries outside Europe have also expressed interest.

Because of the global scale and complexity of environmental research, and due to high costs of environmental research infrastructures, international collaboration is essential. Although the EISCAT_3D consortium is concentrated on northern Europe, and in the existing EISCAT countries, the project team has a strong commitment to creating a facility which is truly international — as the current EISCAT Scientific Association is. Mechanisms will be put into place to ensure that EISCAT_3D is available to the entire global scientific community, and that a wide range of future international users are involved in the Preparatory Phase project.

Of great importance to the RI is collaboration with African partners. This is especially due to the fact that there is a similar radar facility proposal for the African equatorial region which, when created, should be integrated in the environmental research global network, already formed by existing global radar facilities. Radar facilities of this type (incoherent scatter) are unique in their measurement capability and the emerging future need for more earth system science support demands data from these facilities in a global coverage. Having a good connection and coordination between Europe and Africa is essential in future enlargement phases of the global network, but specifically for earth system studies along the European longitude, from high latitudes to the equator and beyond. So the benefit is certainly mutual between Africa and Europe.

There are many ways for African partners to participate in the EISCAT_3D, ranging from sending ideas or becoming users to joining the working groups (through which EISCAT_3D is engaging with the scientific community) or becoming members of the consortium. Individual scientists can gain access to the RI through its peer review program. They can submit a proposal for radar experiments which is evaluated by a panel of experts. Authors of the best proposals will receive free and open access to the RI. Scientific organisations located in Africa, upon payment of a fee, can also become members of the scientific association that governs EISCAT_3D. In addition, any institute located in Africa, can register as an "Associate Partner" of EISCAT_3D. This is a purely honorary category of association, which implies no financial commitment to the project. The intention is to provide a means by which the wider community can associate themselves with the aims of EISCAT_3D, and to demonstrate the existence of a diverse user community which clearly understands the benefits of the new infrastructure.

Such collaboration would act as a driver for the development and testing of new radar techniques, facilitate the education of young scientists and engineers on both continents, and contribute to solving the environmental issues that mankind faces in the 21st century.

4.2 Africa's potential to host European research infrastructures

In a survey among ESFRI and some non-ESFRI projects, a question was posed about the potential for Africa to host some European RI. In most cases the response was a medium to low potential, without any indication of what those RI could be and in what country it could be hosted.

ESFRI projects that responded with an indication that there was indeed a potential for hosting RI on the African continent are discussed below.

4.2.1 EISCAT_3D

EISCAT sees a high potential that Africa could host facilities for ISR (Incoherent Scatter Radar**)** and satellite tomography in Ethiopia. There is existing collaboration with the Satellite Tomography Network and the AMISIR (Advanced Modular Incoherent Scatter Radar) in Ethiopia. EISCAT indicates that a proposal exists to partner with distributed RI to be located in Ethiopia. The proposed RI location at a nearby longitude, but close to the equator, offers huge new opportunities in ISR related science, when combining information from European and African RI.

4.2.2 EU-SOLARIS

A high potential to host EU-SOLARIS partner RIs in Africa is foreseen. The high radiation levels found in Northern and Southern Africa offer good testing conditions for Solar Thermo-Electric (STE) technology. Furthermore, STE technology could offer prime solutions for industrial energy production in arid African areas, and is as such already starting to be used industrially in such areas, thereby promoting the need for development – and research – in these technologies.

4.2.3 ELIXIR

It is foreseen that a high potential exists to establish ELIXIR hubs in Africa and that the result will be improved bioinformatics capacity and infrastructure on the continent.

4.2.4 WINDSCANNER

The Windscanner project sees a high potential for establishing similar facilities on South Africa to collaborate on wind energy research in the coastal region.

4.2.5 CLARIN

CLARIN as a distributed data-infrastructure focused on language data, foresees high potential to expand their existing collaboration to include nodes in Africa. Every country hosts its own digital repositories and service centres, which can become part of the CLARIN infrastructure. Governments from third countries can join CLARIN ERIC, the governing body of CLARIN. It is known from existing or past collaboration that South Africa and Egypt have the potential to join, but this could also apply to other African countries that have an operational research network and digital repositories with language material connected to it.

4.2.6 European Marine Biological Resource Centre (EMBRC)

Pending EU and African policy (and political) developments, the European ESFRI RI concept could be internationalised to include extra-European partners, including African partners[10]. There is a clear need for this because marine biodiversity is world-wide and most of the marine biodiversity is found in the tropics, hence outside Europe. EU end-users and African end-users need access to marine biological resources all over the world and they need on-site state-of-the-art RI to carry out their research effectively and efficiently. This needs funding and regulation of IPR issues between hosts and hosting institutes and countries.

African marine biological research institutes, with the financial backing of states rather than individual researchers could become members of EMBRC if, and only if, EU policies on internationalisation of ESFRI RIs permit such inclusion of extra European partners as full members and if such members fit within the vision and objectives of EMBRC.

Complementary facilities in Africa include the Sam Nujoma Marine and Coastal Resources Research Centre SANUMARC in Namibia, Marine Biotechnology at the University of Cape Town in South Africa, The Institut National des Sciences et Technologies de la Mer, INSTM, in Tunisia and the Hurghada Environmental Protection and Conservation Association (HEPCA) marine station in Egypt.

4.2.7 LifeWatch

LifeWatch is working with SANBI in South Africa and foresees a high potential of SANBI hosting a LifeWatch node in South Africa.

4.2.8 Microbial Resource Research Infrastructure (MIRRI)

There are complementary facilities in Kenya in East Africa that MIRRI collaborates with and they foresee a medium potential that these could host RI of interest to MIRRI as part of a National Network of Biological Resource Centres.

4.2.9 ILC-HiGrade

A medium potential is foreseen that South Africa could eventually host a linear collider complementary to the ILC.

4.2.10 ERINHA- European Research Infrastructure on Highly Pathogenic Agents

ERINHA is still in the planning phase and will be a pan-European distributed Research Infrastructure aiming to reinforce the European coordination and capacities for the study and the surveillance of highly pathogenic micro-organisms. It will provide open access to state-of-the-art BSL4 (Bio-Safety Level 4) facilities to enhance basic and targeted research activities and diagnostic activities. The infrastructure aims to promote the harmonisation of bio-safety and bio-security procedures, to develop standards for the management of biological resources,

[10] Prof Dr Enrico Alleva

diagnosis of group 4 pathogens, and to develop training of BSL4 labs users.

In the context of the emerging and re-emerging infectious diseases involving highly pathogenic micro-organisms, the global community has to be well-prepared to face such threats. However, the BSL4 capacity in Europe is not adequate to cover the efficient development of diagnosis, prophylactic and therapeutics means against these pathogens. Moreover, there is no global coordination of activities and harmonisation of practice in this field. The ERINHA project proposes the creation of a top world-class BSL4 research infrastructure that will address the actual European capacity sparseness. Wide-ranging cooperation with African partners (becoming users, members of ERINHA or hosting BSL4 laboratories in African countries) is desirable as most of the pathogens examined at ERINHA are present in the African region. African participation would therefore enable European researchers to have access to patients and new samples. Such collaboration would also contribute to creating a truly international network of BSL4 laboratories that will allow for efficient exchange of information and experience between researchers and, in effect, improve the response to health threats at the global level.

4.2.11 SKA and radio astronomy

Since the announcement that South Africa, along with its eight SKA partner countries in Africa (Botswana, Ghana, Kenya, Madagascar, Mauritius, Mozambique, Namibia, and Zambia), will host the mid-frequency dish array and dense aperture array of the SKA telescope, this has become one of the best examples of how global RI and specifically one project of ESFRI could be hosted by the African continent. Australia will co-host the low-frequency array telescopes. South Africa is already in the process of establishing the MeerKAT dishes, the precursor of the SKA.

Before the SKA hosting announcement, a workshop in Brussels in May 2012 on funding opportunities for African-European radio astronomy partnerships[11] brought together Members of the European Parliament, officials of the European Commission and the European Investment Bank, as well as leading African and European radio astronomers and representatives of global industry. The workshop defined the next steps to establish a dedicated African-European Radio Astronomy Platform (AERAP) by the end of 2012.

AERAP will aim to leverage cooperation in radio astronomy as an instrument to advance scientific discovery, to improve knowledge transfer and education, and to promote development and competitiveness in Africa and Europe.

Discussions focused on how the radio astronomy community could best leverage Africa-EU funding opportunities for scientific and education cooperation, including researcher mobility and student and staff exchange programmes, as well as industrial partnerships in areas such as ICT, energy and advanced manufacturing.

4.2.12 CTA

The Cherenkov Telescope Array (CTA) is an advanced facility for ground-based high-energy gamma-ray astronomy and is an ESFRI project. With two sites, in both the southern and northern hemispheres, it will extend the study of astrophysical origin gamma-rays at energies of a few tens of GeV and above. It will enable the first complete and detailed view of the universe in this part of the radiation spectrum and will contribute towards a better understanding of astrophysical and cosmological processes. The project is driven by Max Planck Institutes in Germany. In a possible design scenario, the southern hemisphere array of CTA will consist of two types of telescopes with different mirror size in order to cover the full energy range. The low energy instrumentation will be placed in the northern hemisphere with a moderate field of view. Researchers from Namibia and South Africa are involved in the design phase. A consortium of 27 countries is

[11] http://www.ska.ac.za/newsletter/issues/17/14.php

participating in the design, including South Africa and Namibia from Africa. The hosting of the southern hemisphere part is still undecided, with Africa and South America as potential contenders.

5 Potential for African-European partnerships on other RI

The survey was extended to some non-ESFRI projects. The non-ESFRI projects responding positively to the potential for hosting RI on the African continent are discussed below.

5.1.1 EDGI (European Desktop Grid Infrastructure)

Unused computing time can be put to good use for science or business applications. Using the idle resources can boost the effectiveness but reduce costs for any computational intensive research. For countries that do not have a large computer infrastructure to support science yet, desktop grids is an opportunity to catch up quickly. Desktop grids can be seamlessly integrated into existing scientific computing infrastructures world-wide. Hence African scientists can more easily collaborate with scientists in other universities, countries and continents. A medium potential is foreseen that any African country may host an IDGF volunteer or institutional grid. A roadmap[12] exists on what desktop grids can do for science.

5.1.2 European Plant Phenotyping Network (EPPN)

The European Plant Phenotyping Network, linked to the Jülich Plant Phenotyping Centre (JPPC), the German Plant Phenotyping Network (DPPN) and the International Plant Phenotyping Network (IPPN) aim at improved plant performance also in respect to yield, resource use efficiency and abiotic and biotic stress resistance. These issues are of high importance to African Agriculture and Breeding as well as to the specific requirements linked for African researchers. It would be highly beneficial to develop adequate and appropriate RI for plant phenotyping in Africa. EPPN could provide an enormous potential for developments in and to any country in Africa as well as for the access to a high-tech options in plant phenotyping to African researchers.

5.1.3 HP-SEE High performance computing infrastructure for SEE

High-Performance computing facilities and National Grid Initiatives could and should be set up in Africa, and they should be federated. Then they could peer with PRACE, LINKSCEEM, HPSEE in HPC technology, and EGI in GRid, etc. This could expand existing activities that HP_SEE has collaboration with such as Grid initiatives around Ubuntunet and CHAIN project in Malawi and the South African Grid Initiative.

5.1.4 Virtual Atomic and Molecular Data Center (VAMDC)

Any RI using Atomic and Molecular Data could connect to this RI. VAMDC is trying to build partnership with any country in Africa as it does with other continents thanks to the SUP@VAMDC that is currently in negotiation with Brussels.

5.1.5 WeNMR

WeNMR is a worldwide e-infrastructure for NMR and structural biology.Current collaborations exists with the National Liver Institute in Egypt, the University of Cape Town, South Africa, the University of the Free State, South Africa and the Covenant University in Nigeria. The South African grid (SAGrid) is already supporting the VAMDC RI in terms of grid resources.

5.1.6 Nordic Optical Telescope

In terms of forming a partnership with this RI, it was suggested that South Africa (or the NRF in particular) could join the ERA-NET ASTRONET as an Associate Member. A complementary facility in South Africa is the Southern African Large Telescope (SALT). The Square Kilometer Array (SKA) could extend the reach of this RI. Another potential global-scale project is the Cherenkov Telescope

[12] http://desktopgridfederation.org/documents/10508/57919/RoadMapGH.pdf

Array (CTA), which is being discussed in the appropriate fora, such as the OECD Global Science Forum.

6 Role of PAERIP in promoting RI partnerships

The learning from case studies on the status of collaboration between African and European RI and the thinking about partnership formation around RI, now lead to a few guidelines to ensure that PAERIP has an understanding to promote and encourage partnership formation between African and European RI in future.

The question remains on how best PAERIP can promote these partnerships. PAERIP will ideally:

- Create an awareness of the potential of partnerships and the benefits they can bring to the science, technology and innovation community
- Suggest minimum conditions for successful partnering on RI
- Play an advocating role, influencing entities that can initiate and fund these partnerships to investigate proceeding with action and support the decision makers on RI investment with knowledge of what RI exists on the European and African continents, what collaboration exists and what collaboration could lead to more formal partnerships
- Point out the added value that RI partnerships can bring
- Provide guidelines for future RI partnerships

6.1 Awareness of the potential to partner

It is generally considered that the lack of awareness of Africa's science and technology strengths in Europe is one of the primary factors inhibiting greater African-European cooperation. This situation also pertains to research infrastructure and the PAERIP inventory seeks to address this. The PAERIP inventory can also be used to identify other case studies where high potential exists where European RI can collaborate with African RI and where researchers from Africa could add value to the roll-out of the ESFRI road map. Potential and existing collaborations of African RI and European RI are indicated in the inventory and could be pursued by the coordinators getting into touch with each other and establish the real need and level of collaboration. For this to work well, an awareness of what is available and what is possible needs to be created.

6.2 Minimum conditions for successful partnering around RI

The following is a set of minimum conditions for successful partnering around RI

- There must be a well-defined common need, based on increased competitiveness, geographic advantage, knowledge advantage, common threats, etc.
- There must be a champion that takes ownership of the RI
- The RI must be justified to be developed and placed at intercontinental scale (which may lead to global RI)
- The RI use must lead to collective knowledge generation, leveraging international funding, promoting access and the mobility of researchers and addressing continental or global challenges
- There must be recognition of mutual advantage to all partners
- There must be a common will to jointly conceptualise, plan, develop, implement, commission, operate, manage, use and phase out (when required) RI
- There must be co-investment at the level of any of the stakeholders as outlined in this report (government, research societies, institutions, research peers)
- The RI must be linked by advanced communications, and connectivity and

data sharing, security and curation must be practiced
- The RI must have the potential to run at optimum productivity of research outputs
- Scientists making use of RI through partnerships must contribute to the knowledge base of the science involved in the RI
- The partnership must extend the reach and impact of the RI
- The strategic objectives of all partnering entities must be strengthened through the RI partnership
- Building community around the RI is essential
- All scientists utilising the RI must benefit from its use and be considered as full contributors
- Conditions of access must be clear
- Excellence in science is a non-negotiable qualifier for all partnerships
- RI must contribute to socio-economic development in the immediate region where it is hosted as well as indirectly to the country and the continent (see PAERIP report on Analysis of the socio-economic impact of African-European research infrastructure cooperation, Work Package 3.3, October 2012)
- The host country must find funding to implement and operate the RI

6.3 Advocating and influencing RI partnerships

PAERIP is a short term project that cannot assume the responsibility to play the role of a broker of partnerships, since the development of such RI partnerships are specific, may take long and are complex.

- The main role of PAERIP is to advocate, encourage, endorse, provoke and urge the formation of RI partnerships by accumulating knowledge and building a cohesive view on all aspects of RI partnership formation
- This knowledge and guidelines should be transferred to policy developers, politicians, investors, the scientific community RI hosts and owners

6.4 Added value of RI partnerships

To engage in RI partnerships there must be added value for all parties. Added value from Africa-Europe RI partnerships for European based RI and RI that could potentially be hosted on the African continent is outlined below.

6.4.1 European RI

The following is identified as added value for European RI that partner with African RI users. Such partnerships will also motivate the completion of implementation of ESFRI projects:

- Centralised RI of global nature that are on their own well networked (such as CERN) will always attract foreign users and collaborators. This type of collaboration will have the highest potential for influencing successful delivery of European RI projects.
- Distributed RI that could benefit from extended reach such as biobanks, geophysical sensing and monitoring, biodiversity networks and databanks will greatly benefit from collaboration and partnerships.
- RI that provides services that are not available on a continental basis in Africa such as synchrotrons will benefit from extending their user base to well-networked researchers that could largely contribute to the knowledge base in synchrotron science.
- Working with world class scientists from Africa will broaden the knowledge base
- Obtaining a different perspective of science and society by being exposed to new approaches to research from a different continental perspective
- Gaining access to African data that may be unique
- Finding new application markets for innovations

- Ensuring high capacity usage of facilities
- Becoming globally oriented in the management of RI

6.4.2 Unique comparative advantages Africa may have to host European infrastructures

The comparative advantage for the continent of Africa to host certain RI is based on either one or a combination of the following:

- Geographical advantage
- Knowledge advantage
- Biodiversity advantage

Geographical advantage includes unique science that can only be done based on the geographical location and involves aspects of space science (astronomy, space geodesy, satellite observation, magnetism and radiation); oceans, islands and coast lines; earth science (geodata, dating, and marine geology), palaeosciences; human genetic diversity, health and longitudinal studies and the continent's rich diversity in peoples and cultures.

Knowledge advantage deals with the established knowledge base of scientific excellence nurtured in an environment very different to that of the North. This can relate to a variety of different disciplines such as those dealing with the natural resource base, health, social sciences and humanities etc., but also indigenous knowledge on a variety of aspects ranging from traditional medicines, farming techniques, manufacturing and social context.

Comparative advantage in biodiversity includes marine and terrestrial biodiversity. Observation and research sites and networks, biobanks, natural history collections, datasets, etc. form an important aspect of RI in biodiversity. Unique specimens, ecological balances and biodiversity spheres are also a function of the geographic position and RI specialised for such studies can best be hosted on location.

The uniqueness of the continent in many aspects in these three dimensions could make placement of RI in Africa a very attractive proposition.

On the other hand, Africa may also have some scientific knowledge advantages in some of the technology driven research areas where it competes with the rest of the world. These include: ICT, biotechnology, manufacturing technology, energy technology, nuclear technology, resource-based industries, frontier science and technology such as nanotechnology, next generation energy technologies, genetic engineering, drug research, etc.

Another advantage some African countries may have in hosting RI is their experience in terms of managing large science projects. The financial systems and administrative systems may be well suited for establishing large RI in a specific country and the legislative environment may be less complex than in other areas.

From a construction and labour point of view costs in Africa may be lower in certain countries to erect and maintain large shared RI. The skills base to support the science in the RI is not a major issue anymore, since scientists involved in the RI are trained in the international arena.

A strong science and research policy environment must be maintained by governments to support their countries hosting international RI. Not only must governments provide guidance on strategic choices of RI to be hosted, but must exhibit political stability for international investment. National and continental road maps should be developed so that it becomes clear what RI Africa should acquire and host, in collaboration with other continents, but specifically in the PAERIP context with Europe.

6.5 Guidelines for Future RI partnerships

In future planning of partnering on RI in Africa and Europe, the following questions should be guiding the process:

- Where do continental RI roadmaps (assuming Africa will develop one with time) overlap, align and resonate?
- What are the horizons for long range joint RI planning?
- What are the roles of the European Union and the African Union in enabling RI partnerships?
- Which other regions should Africa and Europe involve in a more globalised approach to RI?
- What policy frameworks are necessary to succeed in RI development?
- How should governments partner to develop new RI?
- How should scientific communities and professional organisations partner to lobby joint RI development?
- How can partnerships among scientific peers be strengthened into a bottom-up approach to intercontinental RI development?
- Where is the best location for placement of an RI?
- How best to interlink RI?

7 Conclusion

PAERIP has created a platform for understanding and advocating actions on the formation of RI partnerships by studying existing African and European RI that are already collaborating and could potentially benefit from forming partnerships and by pointing out the different dimensions of partnerships that could be forged. This report serves as a baseline for further development of the concept of RI partnership and debate on the subject. It is intended to be a catalyst for discussion at a public workshop in London in October 2012 after which it will be refined and form a part of the final PAERIP deliverable.