Baltic Science Network

Connecting Through Science

Creating a Unique and Sustainable Value Through Scientific Excellence in Photon and Neutron Science in the Baltic Sea Region

Report of the Expert Committee

Interreg Baltic Sea Region

EU STRATEGY FOR THE BALTIC SEA REGION FLAGSHIP

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Project in brief

Baltic Science Network (BSN) serves as a forum for higher education, science and research cooperation in the Baltic Sea Region (BSR)[1].

BSN is a policy network gathering relevant transnational, national and regional policy actors from the BSR countries. The Network is a springboard for targeted multilateral activities in the frame of research and innovation excellence, mobility of scientists and expanded participation. These joint activities are modelled with an overall aim to ensure that the BSR remains a hub of cutting-edge scientific solutions with the capacity to exploit the region's full innovation and scientific potential. The activities are modelled as examples of best practice which form basis of the policy recommendations drafted by the Network.

The platform is tailored to provide advice on how to enhance a macro-regional dimension in higher education, science and research cooperation. Recommendations jointly formulated by the Network members address the European, national and regional policy-making levels.

BSN is a flagship of the European Union Strategy for the Baltic Sea Region (EUSBSR) under the Policy Area Education, Research and Employability, as well as one of two

[1] BSN's definition of the Baltic Sea Region follows the membership of the Council of the Baltic Sea States (CBSS), cf. CBSS Terms of Reference 2009.

cornerstones of the Science, Research and Innovation Agenda of the Council of the Baltic Sea States.

One of the network's missions is the development of joint transnational strategies for scientific excellence (Work Package 3, Activity 3.2). BSN identified areas of scientific excellence in the region and assembled expert groups in these areas in order to develop recommendations to further transnational cooperation in the BSR. The following working paper contains the recommendation of experts from the field of Photon & Neutron Science and provides input for both research institutions and policy makers on national and EU-level on how to enhance cooperation in this area of research in the BSR.

This working paper is based on the input from independent experts. Contents of the working paper do not necessarily reflect the views of the Baltic Science Network, or participating states represented in the Baltic Science Network, or international organisations engaged in the Baltic Science Network. Baltic Science Network cannot be held responsible for any use, which may be made of the information contained herein.

Table of Contents

1) Strategic Goals

The recommendations by the independent expert group listed below suggest measures to improve cooperation in the Baltic Sea Region in the field of photon and neutron science. Thereby, the recommendations follow four overall strategic goals:

- **Maintaining and fostering scientific excellence**: The Baltic Sea Region hosts a plethora of excellent research institutions and infrastructures and brilliant scientists. Both research infrastructures (RI) and policy makers should focus on maintaining and fostering this level of scientific excellence.
- **Encouraging interinstitutional and transnational cooperation**: In order to foster and maintain scientific excellence in the BSR, policy makers and research institutions and their representatives need to collaborate closer to meet the needs of a knowledge-based society. With the variety of skills and knowledge in the field of photon and neutron science in the region, transnational cooperation needs to be at the core of this collaboration in order to use the existing expertise and infrastructures to their full capacity.
- **Overcoming the participation and innovation gap**: Potential for scientific excellence is given in all member states of the BSR, but especially the EU-13 countries (i.e. countries that joined the EU in 2004 and later) are still lagging behind when it comes to acquiring funding for scientific research and participating in large-scale projects due to a lack of funding. To ensure the prosperity of the whole region, it is necessary to undertake measures to bridge the participation and innovation gap and widen participation.
- **Enabling the transfer of knowledge and innovation to society and industry**: Basic research and industry-driven research do not exclude, but on the contrary stimulate each other. RI and policy makers should support measures to transfer knowledge from RI to industry and thus foster to societal advancement.

2) Introduction

The Baltic Sea Region is one of the most competitive, innovative science macro-regions in the world, with an excellent structure of leading universities and research institutions. However, the BSR features different levels of research and innovation performance and existing facilities are not equally distributed and interconnected.

The Baltic Science Network was initiated to improve cooperation in the BSR within science and research. Common challenges require joint strategies in research within the region to pool and share competences to make it more competitive. The currently existing "pockets of excellence" need to align strategically and find new ways of cooperation in order to strengthen the region vis-á-vis existing and upcoming scientific superpowers to ensure knowledge-based prosperity and growth both in the macro-region and the European Union. Hereby, added value should be created for both science and society.

BSN chose to explore the opportunities of transnational cooperation in three fields of scientific excellence: Life Sciences, Welfare State Studies and Photon Neutron Science.[2] The present document will give recommendations on fostering cooperation in the field of photon and neutron sciences with a special focus on Widening Participation, i.e. bridging the innovation gap between EU-15 and EU-13 countries, and cooperation of RI of all sizes in the region.

Cooperation in photon and neutron sciences is important in order to solve current and future challenges. Societal challenges like health issues, climate protection or power supply are not limited within one country's borders. There is the need for long-term thinking, sustainable solutions and new technologies. This fact is recognised beyond the European borders and is also tackled by e.g. members of the Organization for Economic Co-Operation and Development (OECD)[3].

Therefore, photon and neutron sciences have a key position for achieving the EU´s H2020 goals, like excellent science, industrial leadership and societal challenges[4].

The BSR has a rich history of innovative science and scientific collaboration, especially in the field of photon and neutron sciences. The existing strong RI attract excellent researchers from all over the world and make up the nucleus for innovative science and research.

[2] Scientific Excellence: Joint Potentials in the Baltic Sea Region – an explorative study
[3] OECD Science, Technology and Innovation Outlook 2018
[4] Horizon 2020 in Brief

Research infrastructures play a crucial role in maintaining and furthering science development and science collaboration, especially in the field of photon and neutron sciences. As it is put in the Horizon 2020 work programme 2018-2020:

> *"Research infrastructures play an increasing role in the advancement of knowledge and technology and their exploitation. By offering high quality research services to users from different countries, by attracting young people to science and by networking facilities, research infrastructures help to structure the scientific community and play a key role in the construction of an efficient research and innovation environment. Because of their ability to assemble a 'critical mass' of people, knowledge and investment, they contribute to national, regional and European economic development. Research infrastructures are also key in helping Europe to lead a global movement towards open, interconnected, data-driven and computer-intensive science and engineering."*[5]

Thus, the fostering cooperation of RI is of outmost importance on national, European and global level. A variety of RI exist in the BSR, from large-scale flagship RI such as the European x-ray Free Electron Laser, European XFEL, located in north Germany near DESY and the European Spallation Source, ESS, in Southern Sweden to a plethora of smaller, specialised laboratories with complimentary capabilities. In order to ensure meaningful division of work and enable countries with smaller budgets for science, research and innovation to participate in and contribute to a knowledge-based society, smart schemes and incentives for collaboration between large-scale and small-scale RI need to be devised.

Although geographical proximity is not necessarily a prerequisite for collaboration, the research infrastructures in the BSR can benefit from the fact that its macro-regional policies are the ones which are most advanced and farthest developed within the EU. With the political framework given by the EU with the European Strategy for the Baltic Sea Region (EUSBSR), actors from regional RI should take up the opportunity to shape the science policy and the funding of science of the region. Eventually, this could allow them to use both structural and cohesion funds to strengthen their cooperation and thus the macro-region.

Additionally to large-scale research infrastructures like PETRA III at DESY (Germany) and MAX IV in Sweden, new infrastructures such as European XFEL (Germany), ESS (Sweden), SOLARIS (Poland) and the PIK research reactor at the Petersburg Nuclear Physics Institute (Russia) complement the research possibilities and thus research

[5] Horizon 2020 Work Programme 2018-2020 – 4. European research infrastructures

excellence in many areas is possible and already existing. This new cluster of facilities bears the opportunity for joint research projects and gives a good starting position for common research roadmaps, strategies and agenda-setting processes to propel scientific and innovation excellence.

The BSR can be seen as a model region in the EU for developing and implementing innovative measures in collaborative research and innovation programmes at a national, macro-regional and EU level as it is a test-bed for science cooperation between EU-15 and EU-13 member states by combining and utilising their strengths in order to advance research and innovation.

In addition, the BSR is also unique in the sense that it promotes through its existing and future research infrastructures the further deepening of the science and technology cooperation between EU and Russia – one important geopolitical aspect towards the goal of a durable partnership of the EU with its largest neighbouring country.

In order to strengthen the BSR as macro-region, measures to bridge the participation gap should be implemented when collaborating to ensure the competitiveness of the region as a whole. Therefore, a special focus of the recommendations at hand lies on the aspect of Widening Participation, i.e. improving access to the transnational research landscape for EU-13 countries.

In order to close the innovation gap and enhance the BSR's position as innovative science region, it is the goal of BSN to develop joint transnational strategies for specific areas of scientific excellence. Therefore, *ad hoc* expert groups with science and research representatives from the BSR were assembled after identifying the areas of existing and potential scientific excellence in the BSR[6].

This paper will present the observations and findings of the expert group[7] on Photon & Neutron Sciences and deliver recommendations on how to improve scientific cooperation of RI in the region. The guiding assumptions for the expert discussions were driven by the principles of *Coordination, Collaboration and Cohesion* and their observations and findings were built on a Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis regarding the status quo of RI cooperation in the BSR[8] and taking into account many best practice examples from successful and effective bi- or multi-lateral collaboration schemes or projects.

[6] See Scientific Excellence: Joint Potentials in the Baltic Sea Region – an explorative study
[7] See a list of all experts involved in Annex I
[8] See Annex II for the SWOT analysis

The following dimensions were identified as possible starting points to foster cooperation between the institutions:

- Improvement of cooperation between RI on both organisational and staff level
- Multilateral funding schemes, joint programmes and projects
- Mobility and development of scientific, technical and administrative personnel
- Transfer and innovation, societal acceptance and industrial adaptation

Deriving from these dimensions, the expert group concluded that the recommendations of the group need to address three different levels in order to enhance the cooperation in the region:

- The research infrastructures as institutions carrying out activities and profiting from the cooperation,
- policy makers and funding programmes on national level to provide effective political support,
- and policy makers on transnational and EU level, ensuring that EU legislation and funding is favourable for transnational cooperation.

The recommendations of this working paper are based on the views of the individual experts.

3) Recommendation of the Expert Group on Photon & Neutron Science Cooperation in the Baltic Sea Region

a) Recommendations for research infrastructures

Dimension 1: Improvement of cooperation between RI on both organisational and staff level

- There are broad research opportunities at smaller-scale RI in the Baltic area that are not yet sufficiently explored. This cooperation potential must be better mapped out to exploit synergies.
- The integration of smaller-scale RI and research institutes into the landscape of major RI in the Baltic science region has to be improved. Participation of the scientific user community in collaboration and user consortia around major RI should be encouraged by special in-kind contributions for instrumentation or supplementary facilities.

Successful Example: FinEstBeamS

The Estonian–Finnish Beamline (FinEstBeamS) built to the synchrotron radiation source MAX–IV in Lund, Sweden. The beamline is constructed through the cooperation of four universities (University of Tartu, University of Turku, University of Oulu and Tampere University of Technology). The beamline is producing ultrasoft x–rays enabling research on new materials and their electronic properties. Joint construction of the beamline became possible due to long lasting and active cooperation between the consortium and Lund University. Funding for the basic equipment and instrumentation, materials, and staff during the construction phase was provided by an Estonian and Finnish consortium, supported by the EU through the European Regional Development Fund and the Academy of Finland.

Dimension 2: Multilateral funding schemes, joint programmes and projects

- There are several good examples in the BSR for joint research groups and/or joint professorships across countries. These schemes strengthen the cooperation between RI and universities across the BSR. The installation of further joint research groups and joint professorships in the Baltic Sea Region should be strongly encouraged.
- The major European RI in photon and neutron science are organising themselves in large alliances, for instance such as LEAPS (Leagues of European Accelerator-based Photon Sources)[9] and following this example the LENS alliance (League of

[9] LEAPS Initiative

advanced European Neutron Sources)[10]. These strategic pan-European consortia should also develop macro-regional cooperation initiatives to foster collaboration.

- Calls for funding should be designed in a way that is interesting for both research and industry and thus for the advancing the knowledge-based development of Europe.

Dimension 3: Mobility and development of scientific, technical and administrative personnel

- Support to short- and long-term mobility programmes between RI at all levels should be given, including scientists, technicians, engineers and administrative staff. These programmes should not only be implemented on a junior level, but also for senior staff. This could include sabbatical programmes.[11]
- Training and education schools, for instance summer schools or graduate weeks, and other opportunities for exchanges at RI should be targeted specifically towards participants from the BSR to foster networks in the region.
- There are several good examples of transnationally organised summer schools and workshops in the BSR that bring together young scientists in the BSR creating new collaborations and networks. Examples are the RACIRI and MATRAC summer schools. These initiatives have to be supported and continuously expanded.

Successful Example: RACIRI

RACIRI is a tri-lateral cooperation between Germany, Sweden and the Russian Federation which organises annual summer schools on "Advanced Materials Design" to promote the next generation of scientists in view of the excellent large-scale research infrastructures in the region. The initiative started in 2013 with the organisation of the first summer school in St. Petersburg. Every year about 80 students, pre-dominantly from the three organising countries, but also from other countries in the BSR, come together at a venue that rotates every year among the three hosting countries.

Dimension 4: Transfer and innovation, societal acceptance and industrial adaptation

- RI should become more proactive, exchange and share best practices and engage in joint campaigns to better communicate tangible outcomes and impacts from BSR collaboration – success stories exist, but the RI need resources to package them.

[10] LENS Alliance

[11] It was recognised that although mobility of RI-senior personnel would be advantageous for any RI, even a short term absence of key senior personnel is strenuous for RI and thus has to be facilitated thoughtfully.

- To enhance the overall visibility and awareness, the RI in the BSR should strive for common marketing and communication efforts and strategies towards industry, the society and the general public.
- Ensure there are adequate pathways for industry to be able to access the facilities. Make sure there are processes in place to capture and meet the needs of industrial users.

b) Recommendations to national policy makers and funding programmes

Dimension 1: Improvement of cooperation between RI on both organisational and staff level

- Fostering scientific excellence should be prioritised by national policy makers in order to maintain and develop the knowledge-based societies.
- National policy makers should engage in long-term funding commitments and research programmes, thereby creating reliable framework conditions for a sustainable participation and research at RI in the region. As an example this could include adequate financial support for transnational access to major European RI, in-kind contributions to experiments and equipment at RI, or project, travel or fellowship grants for the national user communities to enable research at RI. A close dialogue and communication to the scientific communities is key to better understanding those commitments.
- National policy makers and funding agencies are encouraged to set up national hubs and platforms in their countries to better coordinate their national RI user communities and to provide sufficient training and education opportunities together with the relevant RI. Such platforms are preferably organised by science topics, ensuring that the services rendered are relevant for potential users in their different fields of enquiry.
- There is a need to open up the existing medium- and smaller-scale RI for international users and to better connect them into the BSR. National funding has to support this integration process. The role of those medium- or smaller-scale RI is fundamental in the development and retention of a national scientific community and creates the root of the international recognition which facilitates the access to international RI.

Dimension 2: Multilateral funding schemes, joint programmes and projects

- National funding programmes have to strengthen international cooperation in variable geometries allowing a much stronger participation in user consortia and projects at European RI.
- Bi- or multilateral collaborative collaboration frameworks such as the Röntgen-Ångström Cluster RÅC and other supported programmes, for instance through EU Interreg funds, have proven to be successful in fostering cross-border collaboration. National policy makers are strongly encouraged to learn from such best practice examples and to establish and widen these partnerships and collaborations.
- National policy-makers and funding agencies in the BSR are strongly encouraged to better coordinate their funding programmes and bundle efforts to achieve more return to the macro-region. The BSR could massively benefit from powerful joint programmes and common funding initiatives which could be modelled after EU flagships and/or national excellence initiatives.
- Intergovernmental organisations in the BSR, in particular the Council of the Baltic Sea States (CBSS) should play a much more prominent and visible role in fostering science and research in the BSR as a shaping factor for a common future.

Successful Example: Röntgen-Ångström Cluster

The Röntgen-Ångström Cluster RÅC is a Swedish-German research collaboration in the fields of materials science and structural biology that aims to strengthen research at synchrotron and neutron radiation sources. Enabled by an agreement between the Swedish and German governments in 2009, the RÅC supports the initiating and development of cooperative research projects between research groups from Germany and Sweden around large-scale research infrastructures.

Dimension 3: Mobility and development of scientific, technical and administrative personnel

- National policy makers and funding agencies should support mobility at all career levels and paths. This includes the provision of legislative and financial frameworks beneficial and supportive for mobility flows without restrictions and obstacles. Synergies with actual EU initiatives are a must to ensure maximum return per Euro engaged.
- Brain drain, in particular in the EU-13 countries, has to be mitigated. It is thus important to create appropriate incentives for the return of the staff after the mobility programme.
- Sufficient institutional capacity building must be developed to turn brain drain into brain circulation including migration into other areas of the national economic system.

Dimension 4: Transfer and innovation, societal acceptance and industrial adaptation

- National policy makers should consider strengthening their supportive efforts for industry-science cooperation, e.g. by setting up national programmes and supporting portals (such as LINX) and by linking collaborative frameworks more to innovation systems.
- National policy makers should invest more efforts in supporting joint marketing, communication and outreach strategies in the BSR.

Successful Example: LINX – Linking Industry to X-ray and Neutrons

The Danish LINX project creates an ecosystem of companies, academic institutions and other relevant actors centred on advanced neutron- and X-ray techniques. The focus is on solving real world industry challenges, whereby the challenges are operationalised and then solved in an academic setting. As a non-profit collaborator, LINX enables companies to tap into the scientific infrastructure, networks and knowledge at universities and large-scale facilities to look closer at fundamental materials issues and entirely new avenues of value creation.

- National policy makers should consider fostering more cooperation between universities and their educational programmes and other actors in the science and innovation system. This cooperation should, for instance, give students the opportunity to work as interns in RI to learn how to use the facilities and give them a better understanding of the facilities for their future career, either in research or in industry.

c) Recommendations to EU policy makers

Dimension 1: Improvement of cooperation between RI on both organisational and staff level

- European framework programmes such as the upcoming Horizon Europe should be used more strategically to enable cooperation in a more holistic way, i.e. better integrating the actors in the knowledge triangle and providing seamless transitions in the research and innovation process from universities, small-scale RI and large-scale RI to industry in project consortia and collaborative frameworks.
- EU framework programmes should support more coordination and support actions around RI and their communities on a macro-regional level. This could include also special BSR twinning and teaming programmes to strengthen the cohesion and integration of EU-13 in the region.
- EU-wide concepts to better integrate and connect smaller-scale RI in EU-13 member states as dedicated partner facilities with complimentary services to major RI need to be worked out.

- Funding on EU-level should address better opportunities to coordinate and advance the build-up of user communities and user networking in the BSR, e.g. through seed money schemes enabling scientists and staff to create new consortia for project applications at RI or contributions in existing user consortia.
- Due to the geography the BSR and its RI are in a unique position to strongly promote EU-Russia cooperation and to connect Russia closer to the European Science Area. Successful EU-Russia collaboration schemes at and between RI exist and should be further expanded.

Successful Example: CREMLIN

CREMLIN is an EU funded project within the H2020 programme to improve and strengthen the relations and networks between European and Russian research infrastructures both at a scientific level and at a research policy level. It was initiated in 2015 by a consortium of 19 European and Russian major research laboratories in response to the "Megascience Initiative" by the Russian Federation to build six new large-scale research infrastructures open for international access in Russia. The CREMLIN project provided the path for more science and technology cooperation among the large research facilities in Europe and Russia. The BSR has played a special role within CREMLIN since several of the cooperating RI are located in the region.

Dimension 2: Multilateral funding schemes, joint programmes and projects

- Raising major seed funds and initiating a BSR-wide flagship call to realise ambitious and visionary research and innovation projects in the BSR macro-region would be a unique opportunity to substantially advance the partnership between knowledge institutions, public entities and businesses and to massively drive the smart specialisation (RIS3) in the BSR. Such calls could be modelled after the European FET programme and targeted to the BSR.
- Future funding calls should include incentives for collaboration in BSR with focus on widening participation and spreading excellence. Such calls would also need to provide adequate co-funding for transnational actions for EU-13 members and possibilities for EU-13 to participate in RI and user consortia, for instance through in-kind contributions.
- Funding for transnational cooperation should become more flexible, e.g. by a better alignment of structural and research funds.
- A focus should be on creating sustainable funding schemes that allow continuation and/or expansion of successful projects after the end of funding period.
- The share of EU funding for EU-13 countries is currently small and dedicated efforts have to be made to support researchers and institutions from EU-13 countries in their funding applications. A common support and service structure to provide information, advice and guidance for EU funds applications for

researchers and scientists from EU-13 countries who are less experienced could help to apply more successfully for research grants.

Dimension 3: Mobility and development of scientific, technical and administrative personnel

- Mobility programmes could have a regional focus, e.g. the BSR, in order to mitigate brain drain. In this context, it is important to include incentives for the return of the exchangees to their home institution in order to build up capacity and mitigate brain drain.
- A special focus should lay on the support of engineering, tech and admin, communicator exchange.

Dimension 4: Transfer and innovation, societal acceptance and industrial adaptation

- EU-level policy makers should consider promoting and supporting industry-science cooperation, e.g. by setting up portals which act as a mediator between industry and RI (like LINX). EU programmes to improve industry-RI cooperation could become a regular part of funding calls, encouraging both RI and industry to cooperate better transnationally.

4) Next Steps

The discussions of the expert group revealed that several successful examples around Research Infrastructures exist that have been proven to be effective in the BSR to drive science and innovation. These examples are excellent starting points, profiting from the experience learned (best practice), to build on and should be further developed and expanded. However, the BSR still suffers from its heterogeneity with partially fragmented efforts and it requires a much wider approach that goes beyond the scope of the expert group to address all the complex and interrelated challenges in the BSR. This could lead to an effective and holistic science and innovation policy framework for the region with concrete actions on all interinstitutional and transnational levels.

Therefore, the expert group recommends the installation of a **BSR Science Forum on Photon and Neutron Sciences** that includes representatives from research institutions, RI, science policy officials and industry from the region. This Forum should be charged to devise a strategic roadmap process for the BSR area to explore in detail the science and innovation capabilities, the business needs and opportunities and the pathways to the future. Such a "business case" for the BSR is a medium-term exercise but would help the region immensely to strengthen its position of a science and innovation powerhouse and tap into its yet undiscovered potential, making it to a macro-regional global champion.

Moreover, the expert group recommends as a short-term measure, to develop a **Photon and Neutron Science (PNS) support action for widening participation** that will strengthen the research capacity and user community of EU13 countries. Specifically, the support action should:

- Support the better integration and connection of small-scale RIs in EU-13 member states as dedicated partner facilities with complimentary services to major RIs in the BSR by matching complimentary research services between them
- Provide advocacy for bi-and multilateral research cooperation projects connecting EU13 and EU15 research infrastructures in order to increase the capacity of EU13 countries to provide scientific contributions to large-scale infrastructures
- Increase the research and management capacity of EU13 science community to utilise their own large-scale infrastructures and to expand their user community for them by providing information, coaching and partner search services

Annex I

Members of the expert group on Photon & Neutron Science

Name	Country	Institution
Andris Anspoks	Latvia	Institute of Solid State Physics
Christoph Quitmann	Sweden	MAX IV Laboratory, Lund University
Deike Pahl	Germany	European XFEL
Enn Lust	Estonia	Institute of Chemistry, University of Tartu
Frank Lehner, Chair	Germany	DESY
Frédéric Le Pimpec	Germany	European XFEL
Jimmy Binderup Andersen	Denmark	LINX – Linking Industry to Neutrons and X-Rays
Kell Mortensen	Denmark	University of Copenhagen, Niels Bohr Institute
Klaus von Lepel	Germany	Ministry of Science, Research and Equalities, City of Hamburg
Marc Thiry	Germany	Helmholtz-Zentrum Geesthacht
Martin Müller	Germany	Helmholtz-Zentrum Geesthacht
Mikhail Rychev	Russia/ Germany	European XFEL & Kurchatov Institute
Rasmus Palm	Estonia	Institute of Chemistry, University of Tartu
Sindra Petersson Årsköld	Sweden	ESS (European Spallation Source ERIC)
Ulf Karlsson	Sweden	KTH Royal Institute of Technology
Ursula Woznicka	Poland	Polish Academy of Science
Wojciech Kwiatek	Poland	Institute of Nuclear Physics PAN

Meeting Schedule

First Meeting: 19 April 2018 at DESY, Hamburg

Second Meeting: 29 June at SOLARIS, Krakow

Third Meeting: 1 and 2 October at Hamburg Representation in Berlin, Germany

Annex II

SWOT Analysis on RI cooperation in the BSR in four dimensions as base of discussion

A. Improvement of cooperation between RI & staff

Internal Factors	
Strengths (+)	**Weaknesses (–)**
Excellent research cooperation already exists in BSR Strong RI backbone – either existing or new facilities – in BSR Geographical proximity of facilities → close network and knowledge about opportunities, easy travel Existing bilateral or multilateral cooperation frameworks such as: RAC, IRI, ESS Cross Border Science cooperation, Nordic Countries	Large-scale RI landscape is fragmented, only concentrated in few areas So far only little "cohesion" has been reached Existing networks/ cooperation structures are impermeable for newcomers Smaller-scale RI are often overlooked Different levels and schemes of national RI funding Long-term investments needed for RI not always viable in all BSR countries
External Factors	
Opportunities (+)	**Threats (–)**
Upcoming Horizon Europe programme; make better use of affirmative action (e.g. SEWP[12]) Integration of smaller-scale RI, e.g. for preparatory and/or complimentary analytical tasks LEAPS as EU-wide strategy platform for photon sources (and future LENS for neutrons) can have positive impact on macro-regional coordination Common training and educational programmes around RI in BSR BSR is the only macro-region with border to Russia, i.e. unique opportunity for EU-Russia cooperation (e.g. CREMLIN) Use common marketing strategy to raise awareness about opportunities in BSR amongst institutions	BSR is not seen as priority area for S&T cooperation/ added value is not communicated clearly enough Increasingly advanced levels of cooperation EU-wide makes macro-regional (on BSR level) coordination superfluous or unnecessary RI will rely on established networks in Horizon Europe applications, emerging institutions are not considered SEWP funds will be mostly used by EU-15 member states in Horizon Europe (see report for evaluation of Horizon 2020 use of SEWP[13]) EC has announced to no longer fund international access to RI RI funding in EU-13 is not high enough to compete/ take part in large-scale operations or projects

[12] http://ec.europa.eu/programmes/horizon2020/en/h2020-section/spreading-excellence-and-widening-participation

[13] http://www.baltic-science.org/index.php/downloads/public/bsn-publications/169-a5-1-study-on-research-cooperation-full-report

B. Multilateral funding schemes, joint programmes and projects

Internal Factors	
Strengths (+)	**Weaknesses (-)**
Growing number of transnational and cross-border activities and actions in BSR Existing cooperation frameworks such as RÅC or NordForsk can serve as models for other cooperation and/or can be expanded to other countries Some examples for participation of EU-13 at RI exist (e.g. FINEST beamline at MAX IV)	BSR has not yet developed to a EU-wide leading macro-region for S&T cooperation Tangible outcomes from S&T cooperation in BSR are not effectively communicated Discrepancies or lack in national funding hinder cooperation or transnational access to RI Funding is missing for development of facilities Political will in some countries not always evident to invest in common/multilateral funding schemes There is a lack of a visible and common "grand challenge" theme in the BSR that would unites the countries
External Factors	
Opportunities (+)	**Threats (-)**
BSR as macro-region within EU has high political visibility and actions are implemented to increase "cohesion" as part of European Territorial Cooperation Good opportunity for EU-13 to get strategic access to RI, e.g. by contributing with in-kind elements to beamline (instead of cash) Remote access to RI could reduce costs of open access Mapping of RI landscape (provided by Baltic TRAM/ BSN) could find matches for more and better cooperation For EU-13 multilateral projects are important as they can leverage more funds (on national level budget limited)	Nationally based funding is dependent on political will and priorities Priorities in BSR countries on S&T cooperation may change; a new "protectionism" could develop

C. Mobility and development of scientific, technical and administrative personnel

Internal Factors	
Strengths (+)	**Weaknesses (–)**
Travelling & working/ relocation in the region is easy due to EU membership A variety of funding tools already exists (but is mostly limited in scope/ not focused on the region[14]) Mobility schemes are easy to implement Several University cooperation frameworks already exist in the BSR	BSR is not seen as priority region for mobility; one-sided movement from East to West /North to South prevalent[15] Funding instruments for mobility are too diverse and too fragmented in order to be effective in the BSR
External Factors	
Opportunities (+)	**Threats (–)**
Dedicated BSN mobility funding toolbox for promotion of scientific mobility within BSR RI can serve as anchor points and hubs for mobility and for circulation of staff and researchers	Brain drain → necessity to introduce measures for return (both on institutional and national level)

[14] http://www.baltic-science.org/index.php/downloads/public/bsn-publications/227-researcher-mobility-tools-for-the-baltic-sea-region

[15] http://www.wissenschaftweltoffen.de/publikation/wiwe_2017_verlinkt.pdf

D. Transfer and innovation, societal acceptance

Internal Factors	
Strengths (+)	**Weaknesses (–)**
Vivid discussions on smart specialisation strategies in BSR, visible in political context Innovation pilot activities (e.g. Science Link) around RI successfully launched Several strong RI-industry cooperation links exist in BSR Coordinated approach within several countries	Lack of joint and coordinated activities to increase societal acceptance for research and for RI Innovation ecosphere not yet developed in BSR Still a large gap between research and innovation in many areas Funding gap for mediating activities, meeting the specific standards of industrial users
External Factors	
Opportunities (+)	**Threats (–)**
BSR joint initiatives, marketing and communication Transnational/cross-border studies on socio-economics to make impact more tangible Enable transfer of knowledge through mobility programme	Losing societal and political acceptance for research and RI

Annex III

List of Abbreviations

BSN	Baltic Science Network
BSR	Baltic Sea Region
DESY	Deutsches Elektronen-Synchrotron
ESS	European Spallation Source
EU	European Union
EU-13	Countries that joined the European Union in 2004 or later
EU-15	Countries that joined the European Union before 2004
EUSBSR	European Union Strategy for the Baltic Sea Region
H2020	Horizon 2020 (9th Framework Programme for research and innovation)
LEAPS	League of European Accelerator-based Photon Sources
LENS	League of advanced European Neutron Sources
LINX	Linking Industry to Neutrons and X-rays
OECD	Organization for Economic Co-Operation and Development
PNPI	St. Petersburg Nuclear Physics Institute
RÅC	Röntgen-Ångström Cluster
RACIRI Summer School	Joint initiative by Sweden, Russia and Germany embedded in the collaborative frameworks of the Röntgen-Ångström-Cluster (RÅC) and the Ioffe-Röntgen-Institute (IRI)
RI	Research Infrastructure
RIS3	Research and Innovation Strategies for Smart Specialisation
XFEL	European X-Ray Free-Electron Laser