NEW AREAS AND CURRENTLY FUNDED INFRASTRUCTURES THAT CAN APPLY IN THE CALL FOR INFRASTRUCTURE OF NATIONAL INTEREST 2019

AREA DESCRIPTION: RESEARCH INFRASTRUCTURE NEEDS PER AREA A1, ELIGIBLE TO APPLY IN THE 2019 CALL

This section contains descriptions of a number of areas in which there are research infrastructure needs that are considered to be of great national interest. Areas are infrastructure needs considered to be of national interest and developed enough to be implemented in the near future which makes them eligible to apply in the 2019 call.

New areas eligible to apply in the 2019 call

Contextual databases for social sciences

Challenge: Today's world is facing multiple major known challenges: ageing populations, increasing social inequality, climate changes, conflicts, political populism, changed migration patterns, etc. To address these challenges, knowledge needs to increase of both their causes and their consequences. Furthermore, we need increased understanding of how challenges are related to each other. Within social sciences research, analysis is done of factors such as the consequences of various social, political, economic and environmental structures, and prerequisites for individuals' living conditions, values and behaviours. These prerequisites cover everything from global to local factors, and involve both changeable structures and factors that are difficult to influence. To analyse and understand the actions of individuals, we therefore need not just longitudinal individual-based data, but also data at aggregated, contextual level.

Description: Sweden has a large number of high-quality contextual databases. Swedish research in several of the areas where contextual databases are used is of high international standard. Sweden's position within the research field can be further reinforced through the formation of a national research infrastructure for contextual data. Through increased coordination of existing databases, and in particular future data collection, opportunities are created for pioneering research within fields such as democracy development and social policy.

Swedish researchers have managed to build up several databases for contextbased data. These cover a broad spectrum of contextual information; everything from armed conflict and corruption to the quality of government governance and social security. However, existing databases vary not only in terms of content, but also in terms of time period and number/type of countries covered by data. Some have global coverage, while others focus on high-income countries. Research places very high demands on systematic information relating to contextual factors at various levels. New theories require information on a number of different factors. There is great potential for coordinating and linking various existing databases, in order to create synergy effects that can facilitate ground-breaking research. This applies in particular to global challenges, such as the UN's Sustainable Development Goals for 2030, but also regional analyses, where the population composition, political measures and other contextual factors can vary.

Expected results: Coordinated organisation of contextual databases based on long time-series would enable and facilitate analysis of causes of institutional and societal changes and their consequences for individuals at various stages of life. The focus would move from descriptive analyses to causal analyses. Coordination of this type of databases would promote comparative (country-comparing) research and in this way be of great importance also for the study of sustainable development. In summary, a national infrastructure for context databases is of importance, for both Swedish and international social sciences research.

Infrastructure for brain imaging

Challenge: The brain is our most complex organ, and affects the entire body and our behaviour. As we grow older, the incidence of diseases such as stroke and dementia increases, which does not just impact on the individual but on society as a whole. Research within the area concerns both health and disease, and how the brain processes information. Brain imaging can be carried out using many different techniques,

which are partially complementary. Coordination of infrastructure for brain imaging is necessary in order to enable access for researchers throughout the country. Magnetoencephalography is considered a central need, but other forms of brain imaging can be included, on condition that added value can be gained from the coordination.

Description: NatMEG is the first and only research laboratory in Sweden for overall measurements of neuronal brain activity using magnetoencephalography (MEG). Magnetoencephalography is a method for measuring bio-magnetoelectric signals to reflect the work of the brain in humans, and provides opportunities to measure brain function at millisecond level. The method can localise the brain's activity with great precision and allows study of phenomena that are associated with thinking, experiencing and feeling. The technique is relatively uncommon, with around 170 similar instruments in the world, of which fewer than 50 are in Western Europe.

Expected results: An upgrade of the national infrastructure NatMEG within MEG instrumentation, MEG and EEG analysis and user services in particular, and a possible integration of other existing platforms, would crucially strengthen the competitiveness of Swedish researchers within cognitive neuroscience, clinical neuroscience, clinical implementation, instrumentation and calculation modelling, and is expected to attract additional users within life sciences. The planned improvements would strengthen Sweden's position within the brain imaging area.

Infrastructure for chemical biology

Challenge: Finding out how small molecules with biological activity function and how they can be used is a central part of life science and biomedical research, and also has great potential within plant biology and environmental sciences. Within pharmacology, for example, there is currently only access to well-characterised pharmacological substances for a limited number of all proteins. To enable effective research into new parts of the proteome, development of new tools and methods is needed. It is often too great a challenge for individual research teams to develop and maintain the necessary infrastructure for discovering new small molecules with biological activity, and to characterise and validate these.

Description: Chemical biology includes research methods within chemistry that are used to understand, control and change fundamental biological processes. Screening, characterising and optimising small molecules with biological activity are central features of chemical biology. Infrastructure within chemical biology can also include access to molecule libraries, resources within synthetic chemistry, screening of entire organisms and support for computational chemistry.

Expected results: Within life sciences, research at an infrastructure for chemical biology is expected to lead to increased characterisation of the human proteome, better understanding of biological processes in healthy and ill persons, and identification and development of new medicines. Within environmental sciences and plant biology, an infrastructure is expected to lead to development of new biodegradable biocides and new biofuels, for example.

Infrastructure for experimental research using large animals

Challenge: Translational research means that research questions identified within healthcare are addressed experimentally in a laboratory to provide an answer that can then be implemented in healthcare in the form of improved diagnostics or therapies. Within this type of research, there are needs for various animal models that resemble humans. The use of cows and pigs, for example, for this purpose therefore fulfils an important function. There is also a need for deeper knowledge about diseases in animals that may have consequences for animal husbandry and food production as well as for human health. Better access to models for research into large human is requested both at HEIs and in industry.

To develop the use of large animal models, there is a need for an integrated approach and collaboration between experts in both veterinary and human medicine. A platform where these disciplines can collaborate would enable innovative research, for example within antibiotics resistance, xenotransplantations, ageing, orthopaedics, and cardiology.

Description: In addition to coordinating activities at the various facilities of the infrastructure, education in animal health, animal ethics and relevant surgery for veterinary medicine interventions should be part of the infrastructure. Here, expertise within veterinary medicine and livestock science, which is today available at the Swedish University of Agricultural Sciences, will play an important role. Creating opportunities to carry out long-term studies will also be a task for the platform.

Expected results: Access to infrastructure for large animal models is expected to provide increased opportunities for translational research in Sweden, better knowledge of animal diseases and animal health and, in the longer term, improved methods within healthcare.

Infrastructure for metabolomics

Challenge: Disruption of an organism's metabolism can cause various problems and diseases. Using mass spectrometry, small organic molecules (metabolites) in biological samples can be analysed and contribute to new knowledge about fundamental biological processes. An alternative to mass spectrometry is NMR, nuclear magnetic resonance spectroscopy. The advantage of NMR is that the analysis is absolute quantitatively, and shows a high degree of reproducibility, but the method has relatively low sensitivity and relatively few metabolites have been detected.

The needs of users are increasing, in terms of access to infrastructure, analytical competence and practical knowledge within metabolomics. There is a major technical challenge involved in creating, in a reproducible way, quantitative profiles of thousands of metabolites in varying concentrations, for which a known chemical structure is often lacking. Moreover, areas such as the handling of data, normalisation and linking to other types of data require both specific hardware and software, and also great competence within these areas.

Description: Metabolomics (sometimes called metabonomics or metabolite profiling) is today an integrated part of biological and medical research, and entails identification and analysis of small organic molecules (metabolites) in biological samples. Metabolomics data are necessary to fully understand biological processes and mechanisms. The metabolites provide important biochemical information that can be associated with specific phenotypes or disease conditions. The data analysis requires specialised hardware and software, and a high level of competence in the area.

The methods and techniques used for different types of biological samples are similar, but not identical. There are currently a number of specialist laboratories established as platforms at Swedish universities. A national infrastructure for metabolomics should include applied techniques, methodology development and leading-edge competence that are coordinated for better accessibility for users from differing research fields and business.

Expected results: Opportunities to combine different metabolomics data are expected to generate an increased number of identified metabolites, which in turn can result in increased knowledge about diseases, improved diagnostics and follow-up of therapies. With knowledge about biochemical patterns that can be linked to physiology or pathology, possible drug targets, for example, can also be identified. An important application area for metabolomics is therefore clinical trials, where metabolic profiles are measured to find new biomarkers for diagnosis or therapy follow-up.

Infrastructure for visualisation of data

Challenge: Growing data volumes from different sources in most research fields have led to a need among researchers to visualise complex and multi-dimensional connections in order to understand, interpret and conduct analyses and draw conclusions. Big data are currently generated by simulations, laboratories, empirical experiments, surveys, crowdsourcing, registers and archives, and may cover areas such as geodata, medical imaging, 3D movement patterns, meteorology, astronomy, geography, archaeology, or history. These data are complex, often multi-dimensional and include a lot of white noise. Analyses of complex data are many-faceted and may include patterns, abstract relationships and development of phenomena over time and space. As data, users, suppliers and experts within implementation of visualisation exist within different organisations, access to and provision of visualisation should be broadly available, useable and include user support.

Description: Visualisation is computer-supported development of visual representations of data, aimed at increasing understanding. Visualisation helps researchers to understand large amounts of complex data in various scientific disciplines, and includes processing and presentation of data in the form of graphs, diagrams, maps, images, or animations, for example. A prerequisite for infrastructure for visualisation of data is collaboration with other existing infrastructures, including e-infrastructures. Improved hardware and software systems and open data have led to the visualisation area growing and expanding to cover more and more methods and types of data and areas, which requires expert support and infrastructure for optimal utilisation within the research community.

Expected results: The infrastructure is expected to promote awareness among researchers of visualisation of data as a research tool within many scientific fields that are today using these methods to a limited extent, for example digital humanities, social sciences, geography, and medicine. Increased use of visualisation in research is expected to lead to greater understanding of correlations and causal relationships in complex datasets, and also to better communication of research findings.

MEDem Monitor for Electoral Democracy in Europe: inclusion in ESFRI's roadmap

Challenge: Many of today's democracies are facing a number of clear challenges. For example, several political elections in recent years have thrown up surprising results. As a well-functioning election system is one of the fundamental pillars of modern democracy, it is of the utmost importance to understand how citizens, parties, media and social elites interact and relate to each other when it comes to the battle for votes. In current-day Europe, it is not enough that a country is studied with consideration for the factors mentioned; instead, as many countries as possible should be investigated and compared over as long a time as possible.

To do this, international infrastructure relating to democracy development and voter behaviour is needed, to coordinate the currently dispersed infrastructures, projects, centres, etc. that handle this type of data.

Description: MEDem (Monitor for Electoral Democracy in Europe) aims to establish, operate and develop a pan-European distributed research infrastructure based in Sweden (University of Gothenburg), and with centres also planned for Denmark, Germany, Greece, France, Netherlands and Portugal. A further 20 or so nodes are planned to be included. The goal of MEDem is to be included in ESFRI's roadmap.

The infrastructure shall enable close collaboration between researchers when it comes to data from national elections and elections to the European Parliament, relating to citizens, political parties, social elites, media, and contextual data. Data components shall also be harmonised, and new and old election surveys be linked and accessible for researchers and society as a whole in a database.
Swedish research in this area is of high international standard, and a coordinated push to join up databases with long time series that enable comparative research into voter behaviour is of great importance for social sciences research.

Expected results: This type of infrastructure would provide added value to both social sciences research (politics, economics, sociology, media science, etc.) and for society as a whole. With an infrastructure such as MEDem, research into elections and representative democracy can be strengthened, both in Europe and in Sweden. As a world-leading nation when it comes to election research and democracy surveys, Sweden is well suited to host an international infrastructure of this type.

National coordination of Swedish research ships

Challenge: Sweden has the longest coastline in the EU. The surface area of the neighbouring seas – the Baltic and the three western sea areas Kattegat, Skagerrak and Öresund – is approximately 450 000 km2, which is the same as Sweden's land surface. This means that the marine environment is our most common habitat type. Marine observations are increasingly carried out by autonomous systems, but research is also dependent on direct access to the marine environment via ships. These are often adapted for research and act as platforms for observations and experiments. The research ships and their instrumentation are currently managed by both HEIs and public agencies, and the coordination between them is often limited. The lack of coordination leads to inefficient use of resources and limits Sweden's ability to take a leading part in international collaborations.

Description: Coordination of existing marine research platforms would both make the operation more efficient and benefit research. The greatest needs are for ships, the measuring equipment they are fitted with, and the relevant support personnel. A national infrastructure within marine research should aim to ensure efficient use of resources and open access to research and data, and to be a joint actor for international collaboration. The infrastructure should also coordinate the development of new technology for marine observations.

The infrastructure should continue building on the existing collaboration that currently exists between HEIs and public agencies, and involve the relevant national operators of marine research platforms. Actors that operate marine platforms for other purposes may be included, on condition that resources are made available for research.

The greatest current need is for coordination of ships and measuring equipment for marine research, support for a joint national prioritisation of ship resources and Swedish researchers' access to them, based on open accessibility in competition. The need is not currently assessed to include investments in new equipment or operating costs for new or existing resources.

Expected results: Joining together Swedish research ships and measuring equipment for marine research under a national infrastructure with responsibility for scientific prioritisation, optimisation of resources and technical development will promote national and international collaboration, and contribute to safeguarding the quality of Swedish marine research. The infrastructure will also contribute to the resources being used in a cost-effective way, and to Swedish marine research institutions being attractive partners in international collaboration. Other expected effects of the coordination are increased quality of Swedish marine education and better information for national and international decision-making in the management of the marine environment.

Swedish participation in Euro-Bioimaging-ERIC

Challenge: Strong technical development of imaging technology is revolutionising biology and medicine through the opportunity to visualise, characterise, and measure molecular and cellular functions with a precision that has never previously been achieved. Biological and medical imaging are central to research within most disciplines of life sciences. The rapid technical development gives rise to needs for ever-more expensive equipment and advanced competence to ensure it is used in the right way. There is growing demand from Swedish researchers for access to advanced imaging technology and competence within the area. Swedish membership of the European research infrastructure for biological and medical imaging (Euro-BioImaging, EuBI or EuBI-ERIC) can contribute to reinforcing Swedish research in this area.

Description: Euro-BioImaging was initiated in 2010 and is in the preparatory stage for becoming an ERIC. Sweden currently has an observer role in the organisation, and is now ready to apply for full membership.

Euro-BioImaging is a distributed infrastructure, with nodes in participating countries and a supporting hub shared between Finland, Italy and the international organisation EMBL. The nodes specialise in different imaging techniques, and are funded locally and nationally. The available infrastructures include techniques for medical image processing, multi-modal molecular image processing and advanced microscopy methods for super-resolution microscopy, multi-modal light microscopy, functional fluorescence-based microscopic image generation and image analysis, and correlative light and electron microscopy.

Expected results: Swedish participation in Euro-Bioimaging would give Swedish researchers access to advanced techniques for biological and medical imaging and to competence and methodology development in the area, which is currently not available in Sweden. This is important for the quality and competitiveness of research, but also for Swedish medical technology industry and healthcare.

Swedish participation in European Marine Biological Resource Centre (EMBRC-ERIC)

Challenge: Deeper knowledge about marine ecosystems can contribute to fulfilling the UN's goal for sustainable use of oceans and marine resources. Increased access to marine research data and laboratory organisms is needed to create a clearer picture of the state of the ecosystems and better models for their resilience. As for other global issues, international coordination is a prerequisite, and participation at

European level is expected to be of great benefit, both for Swedish researchers and for a sustainable approach to ocean and marine resources. In association with this, the opportunities for technology development of benefit to research need to increase.

Description: The European Marine Biological Resource Centre (EMBRC) is a distributed infrastructure, aimed at promoting research into marine organisms and ecosystems through coordination of marine field stations and research institutes. EMBRC has been included in ESFRI's roadmap since 2008, and has been an ERIC since February 2018. Membership gives researchers access to research stations, ships, instruments, laboratories, "omics" platforms and other marine infrastructure across large parts of Europe via a service database. The infrastructure also provides large datasets in the form of metadata, sequences and historical time series, for example.

Expected results: Sweden's marine environments are unique in Europe, as they span a very wide range in terms of salinity, climate and access to nutrients. By making Swedish marine environments accessible, data from these can be placed into a global context, thus increasing the understanding of ecosystems on a large scale. Swedish researchers having access to international infrastructure and competence is expected to increase both the quality of Swedish marine research and the mobility of researchers in this field. The international perspective that participation in EMBRC will provide is expected to contribute to greater understanding of local and global changes in marine environments, and thereby how these are affected by changes in climate. Participation is also expected to entail further strengthening of the collaboration and coordination of Swedish marine research stations.

Swedish participation in European Plate Observing System (EPOS-ERIC)

Challenge: Understanding of the Earth's development and dynamics in order to predict natural catastrophes or safely extract natural resources, for example, is entirely dependent on integrated analyses of data from several observation systems. The systems can be passive, such as seismographs, GPS networks and magnetic measuring systems, or active, such as geophysical measurements that are commonly used within energy and mineral prospecting, but also within research. These are linked to observations from many sources, from entire systems of satellites and drilling platforms to samples obtained using hammer and spade for further analysis in laboratories. These methods generate large amounts of disparate data, which must be accessible in a structured and well-documented way to enable their use for research. Linking together data from several different types of international, national and local observation systems and making them accessible to solid Earth research is a major challenge.

Description: The European Plate Observing System (EPOS) is developing a platform for linking together data about solid Earth from research institutes, public agencies, commercial companies and international collaborations throughout Europe and nearby areas. EPOS has engaged researchers and public agency representatives in the work of developing data standards and modelling tools since the project was included in ESFRI's roadmap in 2008. The work of implementing standards and building up an e-infrastructure platform for data distribution, validation, visualisation and modelling started in 2015. EPOS will be an ERIC as from October 2018.

Swedish researchers and public agency representatives have been actively engaged in EPOS since the start. In addition to pure basic research within areas such as seismology and geodynamics, Swedish interest is great within mineral resources and geodesy.

Expected results: EPOS-ERIC is expected to initiate the creation of complementary and supportive national initiatives, which will eventually also contribute to EPOS-ERIC and thereby give researchers in Sweden and Europe access to a multiplicity of data and models. This gives research the opportunity to address urgent questions relating to geo-risks and access to mineral resources, for example, but also entirely new questions. In addition to giving Swedish researchers access to data and modelling tools, participation in EPOS-ERIC would also enable deeper collaboration between Swedish research institutions, and between research institutions, public agencies and research-focused companies.

Swedish participation in the planning, construction and operation of Aerosols, Clouds and Trace Gases Research Infrastructure (ACTRIS)

Challenge: Both the Earth's climate and human health are affected by aerosols and trace gases in the atmosphere. Climate is affected by the amount of aerosol particles in the atmosphere, as they reflect and/or absorb radiation from the sun, and contribute to the formation of clouds. Human health is affected both by airborne particles and by other air pollutants. To understand the link between human impact and natural processes in the atmosphere and biosphere, long-term quality-controlled and standardised measurements are needed of aerosols, clouds and trace gases. These have a relatively short lifetime in the atmosphere, from a couple of hours to a few weeks, which means that their concentrations vary more over time and space than more long-lived compounds. High-quality and long-term measurements of aerosols, clouds, and trace gases are therefore needed for increased process understanding and better description in models. To obtain a clear picture of air quality and climate processes, observations need to be made across borders, and observation data need to be open and easily accessible to researchers.

Description: Operations where aerosols, clouds and trace gases are observed and studied are coordinated within the framework for the European initiative Aerosols, Clouds and Trace Gases Research Infrastructure (ACTRIS). ACTRIS is a distributed infrastructure that has been included in ESFRI's roadmap since 2016, and is now an H2020 Preparatory Phase Project. ACTRIS is expected to be fully operational in 2025.

The infrastructure collects data on physical, optical and chemical characteristics of short-lived compounds in the atmosphere, and the prevalence of clouds in time and space. ACTRIS aims to increase the efficiency of research in its field, by offering researchers a joint platform with facilities, technical support, and education of users. The infrastructure also has a database with entirely open, quality-controlled, and standardised observation data.

Expected results: Through coordinated collection and the entirely open access to observation data, ACTRIS can contribute to the understanding of environment and climate through increased process understanding and better parameters for climate and air quality models. Reliable data on air quality are also of benefit to environment monitors and decision-makers. Sweden can contribute with its specific data to ACTRIS, and Swedish researchers could get access to the infrastructure, including data from other countries.

Swedish participation in ACTRIS would be a complement to existing infrastructures, such as ICOS and SITES. Co-location and coordination with one or several of these is desirable, as this should lead to integrated measurements and thus to better understanding of links between the biosphere and atmosphere, including effects on climate caused by aerosols, such as cloud formation and scattering and absorption of light. Clear added values from co-location and coordination are expected, not just scientifically but also logistically.

Swedish participation in Square Kilometre Array (SKA)

Challenge: Astronomical research focuses on observing and understanding our universe, and its origin and development. Radio astronomy studies astronomical phenomena with the help of radio telescopes. The next generation of radio telescopes is expected to address important scientific questions, such as mapping the re-ionisation epoch of the universe when the galaxies were formed, finding limitations to the state equation of dark energy, and monitoring the development of gas and magnetic fields in galaxies. The hope is to also use observations of pulsars to test gravitation theories and to detect very low-frequency gravitational waves.

Description: Square Kilometre Array (SKA) is an international radio astronomy project, which is at the planning phase and is included in ESFRI's roadmap. It will consist of a number of linked radio telescopes in South Africa and Australia, which will be constructed in phases. The first phase, SKA-1, is expected to be completed in the mid-2020s, and will have 15–20 per cent of the final collecting area of the whole SKA. Despite its limited area, SKA-1 will have considerably improves sensitivity compared to today's radio telescopes. In addition, SKA-1 will be able to conduct considerably faster measurements of the sky than existing radio telescopes. SKA is currently organised as a British limited company, with twelve member

countries including Sweden. An inter-state organisation is expected to be formed shortly, which will construct and operate the telescope.

Expected results: SKA has a broad scientific programme, and is expected to contribute with answers to many of the topical questions within astronomy, astrophysics and cosmology. Sweden has long held a strong position within radio astronomy research, which would be further reinforced through Swedish participation in SKA. There are also good prerequisites for industry contacts with Swedish companies within strategically interesting areas, such as data management, renewable energy, radio antennae and receivers.

Upgrade of IceCube

Challenge: Research within astroparticle physics with neutrinos aims to study high-energy neutrinos – a type of difficult-to-detect elementary particles – and their astrophysical sources. As neutrinos are not deflected by magnetic fields and only interact weakly with matter and radiation, they constitute unique messengers of information from the universe, and can be used to study the origin of high-energy cosmic radiation in supernova remains and starburst galaxies, for example.

Description: IceCube Neutrino Observatory is a neutrino telescope at the South Pole, consisting of light-sensitive detectors placed deep inside the Antarctic ice, with a total volume of around one cubic kilometre. IceCube has discovered neutrinos of astrophysical origin, but has not yet been able to link them to specific sources.

An upgrade of IceCube would consist of two parts. The first part aims to increase the space resolution for detection of high-energy neutrinos. This would be done by densifying the lines of optical detectors in the inner, lower part of the telescope with seven new detector strings with improved detectors. Such densification would dramatically increase the chances of identifying the sources of the detected particles. It would also enable studies of the characteristics of neutrinos, such as mass hierarchy and measurements of the most massive neutrino, the tau neutrino.

The second part of the upgrade aims to measure signals from ultra-high energetic neutrinos, which have long been predicted, but so far never observed. This would be done with the help of radio antennae, located on the ice surface.

Expected results: The upgrade of IceCube would open the door to research into a number of topical questions within neutrino-astroparticle physics. The upgrade would also improve the calibration of the telescope, which would make it possible to conduct new, more precise analyses of the data previously captured by IceCube during the decade the telescope has been in operation. Sweden is also expected to contribute to and benefit from the development work related to the upgrade, within areas as widely differing as advanced radio technology and wind turbines, which are a consequence of the need for energy to drive the experiment.

CURRENTLY FUNDED RESEARCH INFRASTRUCTURES THAT ARE ELIGIBLE TO APPLY IN THE 2019 CALL

Infrastructures that are currently funded by the Swedish Research Council for which the grant period ends in 2019 or 2020 are described in the following section. Here additional instructions are given in the end of the infrastructure description for the infrastructures it concerns.

Ion Technology Centre

The infrastructure provides and develops competence within ion beam-based materials analysis and materials modification. The parties to the consortium formed within the infrastructure are Uppsala University, KTH Royal Institute of Technology and Linköping University. There are a total of three accelerators within the infrastructure which are used in many different ways in the three core activity areas of mass spectrometry, materials analysis and materials modification. There is also considerable support activities in the form of sample preparation and handling in separate laboratory premises.

The infrastructure uses beams of energetic ions in various ways to analyse the composition of different materials with a high level of sensitivity. This can be used, for example, to determine the age of various organic and inorganic samples using C-14 dating. It is also possible to use ion beams to measure the composition of very small amounts of a material, or to produce depth profiles on the nanometre scale without destroying the sample. This is an important prerequisite for enabling research aimed at developing new and better materials within many different subject areas, such as archaeology, climate research, biomedicine, thin film electronics, materials science and fusion research. The ion beams can also be used to tailor material characteristics, or to test and improve electronics components. The two latter categories are also in strong demand by Swedish industry developing/manufacturing electronics components with specific performance characteristics.

AGATA

New international accelerator facilities for studies of extremely unstable nuclei are being constructed or planned in Europe, Japan and USA. SPIRAL2 at GANIL in France and FAIR (Facility for Antiproton and Ion Research) at GSI in Germany (both on ESFRI's roadmap) will become world-leading facilities for experimental nuclear physics when they become operational around 2019 and 2022 respectively. They will be producing radioactive ion beams of very short-lived unstable nuclei with very high intensity. Sweden is a part-owner of FAIR, which will cover most aspects of nuclei and their building blocks, and several nuclear structure physics teams in Sweden are taking part in the preparations. An important part of the engagement at FAIR is the European germanium detector project AGATA (Advanced Gamma Tracking Array), which will be the central detector system in the HISPEC experiment at FAIR. Thanks to its modularity, it will also be possible to use AGATA at SPIRAL2, for example.

AGATA detects the emitted gamma radiation from nuclear decomposition with high energy resolution, which enables the quantum structure of the nucleus to be measured and compared with theoretical models. The scatter pattern of the incidental gamma photons in the detector material can be tracked, and the photons can be characterised in relation to both energy and incidence angle in a way that was previously not possible, which opens the door to new opportunities.

BIS – Biobank Sweden

The national biobank infrastructure Biobank Sweden (BIS), which was established in 2018, includes all universities with a medical faculty and associated university hospital principals (county councils and regions). BIS coordinates and works towards efficient use of biobanks at national and international level. A specific goal for the infrastructure is to improve access to samples and associated

data for researchers in academia, health and medical care and industry. The coordination involves joint standards, quality measures, ethical rules, networks and operational compatibility of data. The biobanks constitute a platform for effective healthcare services, high-quality research and the development of new medical therapies within the biosciences industry.

Samples collected within healthcare and in conjunction with research studies, for example, are accumulated in biobanks and can then be used both for healthcare and therapy, and also for medical research. In order for biobank samples to be used optimally for research and healthcare, they have to be collected and stored in the correct way, and information about the samples has to be accessible. It is important that procedures for collection, storage and withdrawal of samples are harmonised between hospitals, regions and internationally.

Since 2013, Sweden has been a member of the European infrastructure Biobanking and Biomolecular Resources Research Infrastructure (BBMRI-ERIC). BIS is the Swedish node in BBMRI-ERIC, and Sweden holds a leading role in the development of ethical, legal and societal issues (ELSI) within the European infrastructure, which creates collaborations and other opportunities at international level.

BioMS – a national infrastructure for biological mass spectrometry

BioMS is a national distributed infrastructure for biological mass spectrometry and proteomics, with nodes at the universities in Lund, Gothenburg and Stockholm. Each of the nodes is specialised in various techniques for fulfilling the needs of the Swedish research community. Using the technologies on offer, such as chemical proteomics, glycomics and proteogenomics, biologically interesting proteins can be identified and studied qualitatively and quantitatively. Furthermore, different modifications, such as glycosylation and phosphorylation can be analysed, and interactions between molecules studied. The nodes included in BioMS collaborate in order to provide adequate support for users and to organise training within advanced mass spectrometry.

The purpose of the operation is to provide advanced infrastructure for mass spectrometry, including equipment, methodology development and competence, for research within life sciences, biology, medicine and health. Access to the infrastructure is obtained through an application procedure, where the project proposals are prioritised and matched against available equipment.

In the postgenomic era, and through improved instruments and techniques, mass spectrometry has gained increased importance and is now an essential tool within biological and medical research.

E-ELT – European Extremely Large Telescope

E-ELT has been developed by the European Southern Observatory (ESO), where Sweden is one of the member countries. The telescope is being constructed in Chile, and will be the world's largest optical/infrared telescope, with a mirror diameter of 39 metres and will gather 13 times more light than today's largest optical telescopes. The potential of the telescope is entirely dependent on the instruments it will be equipped with, and the opportunities for Swedish researchers to be at the leading edge of early ground-breaking research is to a large extent dependent on their participation in the design of the instruments. As the instruments required are incredibly complex, major international consortiums are needed to develop them. Swedish researchers are currently involved in two of the five instruments that will be installed during the first phase of E-ELT, MOSAIC and HIRES.

Additional instructions: Grants can be applied for surveys (Mosaic and Hires) and for construction, installation, and development of hardware for Mosaic, and costs related to this.

ICOS-SE and ICOS-ERIC – Integrated Carbon Observation System

The ICOS (Integrated Carbon Observation System) initiative, originally initiated by ESFRI, is a distributed European infrastructure that measures and quantifies greenhouse gas uptake and emission between land/water and atmosphere. ICOS has been operated as an ERIC since 2015, and has been an ESFRI landmark since 2016. Sweden hosts the European portal function, ICOS Carbon Portal, which stores and delivers openly accessible and quality-controlled observation data for the entire ICOS.

Within the framework for ICOS, the Swedish Research Council also funds a number of national operations for carbon dioxide flow measurements over land and sea, collected within ICOS Sweden. These operations consist of three tall masts for atmospheric measurements, a sea-based measuring station where gas exchange with the sea is studied, and six ecosystem stations distributed across forest land, wetland and agricultural land At the land-based ICOS stations, there are also supplementary exchange measurements to provide information on the interaction between the atmosphere, ground and vegetation, and in some cases runoff water.

The purpose of ICOS is both to understand local variations in the carbon dioxide exchange, and also to enable quantification of greenhouse gas exchanges across the whole of Europe. To answer questions on subjects such as sources and mechanisms for greenhouse gases in the atmosphere, and any effects of measures aimed to reduce these, cross-border collaboration and comparable high-quality data are necessary. The infrastructure ICOS and its data are thus important to many researchers, both in Sweden and internationally.

ICOS Carbon Portal and the coordination function of Swedish ICOS are both located at Lund University.

Infrastructure for integration and accessibility of data within biodiversity informatics: Swedish LifeWatch/Biodiversity Atlas Sweden

Swedish LifeWatch (SLW) and Biodiversity Atlas Sweden (BAS) are national e-infrastructures within biodiversity, which are currently funded separately by the Swedish Research Council, but on condition of a merger. SLW is located at the Swedish University of Agricultural Sciences, and BAS at the Swedish Museum of Natural History, but the consortiums are made up of a number of HEIs and research institutions. BAS also forms the Swedish node for the international infrastructure Global Biodiversity Information Facility (GBIF).

The purpose of the infrastructures is to make biodiversity data accessible by linking together information from lots of different databases within a common, easily accessible and user-friendly infrastructure. Many millions of observations and registrations relating to biological diversity are made accessible here; everything from museum collections to data from citizen science and inventories are incorporated in standardised formats into a central database and made freely accessible to both researchers and the general public. Analysis tools are also offered, with which users of the infrastructure can link together data on biological diversity with variables such as satellite and climate data, and time and space aspects. Following the merger, the format the infrastructures will use is expected to be based on a fully open source code, which leads to free development of analysis tools that can be shared with users across the whole world. Together, this type of infrastructure enables analyses, models and predictions, and thus increased and broadened knowledge about biodiversity both in Sweden and internationally.

Additional instructions: Within the area a single application is expected which is in line with the strategic direction approved by the Swedish Research Council's Council for Research infrastructures.

ISF – Institute for Solar Physics

Research within solar physics focuses on understanding the structure and dynamics of the solar atmosphere, which is important for astrophysics as well as for a long list of other research areas, such as geophysics, climate research, space physics and biology. Research within solar physics requires access to either ground-based telescopes or space probes and satellites.

The solar telescope with the greatest resolution is currently the ground-based Swedish solar telescope SST. SST is located on La Palma in the Canary Islands, and is operated by the Institute for Solar Physics (ISF), a national infrastructure hosted by Stockholm University. SST is expected to retain its world-leading position until the next generation telescope becomes operational, which is the planned European solar telescope EST and its US equivalent DKIST.

Myfab

Myfab is a national distributed research infrastructure consisting of the four largest Swedish academic cleanroom-based nanotechnology laboratories at Chalmers University of Technology (MC2 Nanotechnology Laboratory – NFL), KTH Royal Institute of Technology (Electrumlab), Lund University (Lund Nano Lab – LNL) and Uppsala University (Ångström Microstructure Laboratory – MSL).

The research carried out at the infrastructure is in fields such as materials science, nanotechnology, information and communication technology, bio-nanotechnology, life sciences, energy research and micro-nanosystems. Myfab offers open access, training and process services to academia, institutes and companies through more than 700 of the best available sets of equipment for micro and nano manufacture and specialised manufacturing processes. Myfab's various laboratories are in part specialised in different application areas and their associated processes and materials systems. Each year, Myfab has more than 800 active users from academia (80%) and from 100 companies and institutes (20%).

NGI – National Genomics Infrastructure

The National Genomics Infrastructure (NGI) has been funded as a national infrastructure by KTH Royal Institute of Technology, Uppsala University and Karolinska institutet since January 2010. The operation aims to give Swedish researchers access to the latest technology for large-scale DNA sequencing and SNP genotyping. Large-scale analyses of DNA and RNA sequences play a central role in biomedical research. Access to a broad range of different sequencing technologies makes it possible to select the combination that is best suited to a specific project. Today, NGI is one the three largest genomics centres in Europe, and via its location at SciLifeLab in Stockholm and Uppsala, it can co-use equipment and competence. NGI also collaborates with other initiatives of a national character – within bioinformatics with NBIS and within data analysis and data storage with SNIC. NGI offers expertise within bioinformatics and statistics that ensures the experimental design is optimal and the project is scientifically productive. The consultative role played by NGI is one of the main tasks of the infrastructure.

NMI – National infrastructure for microscopy within life sciences

National Microscopy Infrastructure (NMI) is a distributed infrastructure for advanced microscopy for research within life sciences. Nodes are located at KTH Royal Institute of Technology, Stockholm University, Umeå University and University of Gothenburg. Each of the nodes has a combination of leading-edge equipment and competence within different microscopy techniques. The infrastructure provides services such as super-resolution microscopy, intravital microscopy, multimodal imaging, cryo-electron microscopy, STED (stimulated emission depletion) and correlative electron microscopy. NMI also provides user support and access to highly specialised equipment and leading-edge competence within the area. The infrastructure also coordinates national and international knowledge exchange within the area.

Access to the infrastructure is obtained through an application procedure, where the project proposals are prioritised and matched against available equipment.

NBIS and Elixir – National Bioinformatics Infrastructure Sweden

National Bioinformatics Infrastructure Sweden (NBIS) is a distributed research infrastructure providing bioinformatics support to Swedish life sciences research. A large part of the operation focuses on bioinformatics support within DNA and RNA sequencing projects, but NBIS also offers support within areas such as proteomics, metabolomics and system biology. The infrastructure provides access to a large number of tools (software, algorithms) and associated user support and training. NBIS is the Swedish contact point for the European bioinformatics infrastructure Elixir.

Elixir is a distributed infrastructure for bioinformatics and biological information, with nodes in 21 countries currently, including leading bioinformatics centres in Europe. The operation is coordinated

from a central hub located at the European Bioinformatics Institute (EMBL-EBI) in Cambridge. Elixir coordinates and integrates resources that the nodes then make accessible to users in the member countries. Elixir thereby provides services such as biological data, tools for analysing biological data, resources for data storage and calculation, and development of methods and standards for this, as well as associated training. Sweden contributes to Elixir, for example via the project Human Protein Atlas, which aims to map the human proteome.

Nordsim and Vega

The Vega Centre and Nordsim, both located at the Swedish Museum of Natural History, merged in 2018 to form the Nordsim/Vega Laboratory. Vega uses laser technology to release materials from geological samples, which can then be analysed using a mass spectrometer. This technology is central for a large range of current research fields, such as geosciences, where it enables both fundamental and innovative investigations of both natural (minerals, fossils, etc.) and synthetic materials in terms of their chemical and isotopic construction, atomic structure (surface and internal), and surface texture. The previous Nordic infrastructure Nordsim is similar, but the material is released using an ion beam instead.

Swedish participation in EATRIS – European Advanced Translational Research Infrastructure in Medicine

European Advanced Translational Research Infrastructure in Medicine (EATRIS-ERIC) supports the development of new medicines, diagnostic methods and vaccines within pre-clinical and clinical research.

The infrastructure consists of a consortium of more than 80 different academic centres in Europe, where Sweden is included as a node with seven national centres, coordinated from Uppsala University since 2015 (official status as member since 2018). Through EATRIS-ERIC, researchers can gain access to various resources necessary for translational development of new medicines, such as existing infrastructures, specialised equipment, expert knowledge, education, sample collections and guidance through regulatory processes. EATRIS-ERIC consists of five product platforms that together cover translational medical research: Advanced Therapy Medicinal Products (ATMP), which includes gene therapy and regenerative medicine, bio-markers, medical imaging and trace molecules, small molecules and vaccines.

EATRIS-ERIC offers matching of researchers, pharmaceutical industry and academic research centres to support inter-disciplinary collaboration within medical research. EATRIS-ERIC can also offer support from a multi-disciplinary team throughout the development process, from proof-of-concept to clinical trials.

SUPPLEMENTARY GRANT

Apart from for the infrastructures listed above, grants can also be applied for to fund increased Swedish involvement in international infrastructures in which Sweden already is a formal member. Supplementary grant should cover costs for clearly defined Swedish scientific activities such as calls for in-kind contributions or similar, where Swedish scientists intend to contribute and require additional funding to do so.

Conditions for the supplementary grant

- The infrastructure has initiated or will initiate a call or similar process in which researchers or organisations in the member states can apply to participate with scientific equipment and/or competence to the infrastructure.
- Only one university have to apply.

The instructions for the call are adjusted when applying for Supplementary grants, in the following ways:

Scientific plan: The instructions for the call should be followed. When information is asked for concerning an *infrastructure* this information should be given for the *specific scientific activities included in the Supplementary grant*. It should be clearly stated which scientific advantages for Sweden that the grant will entail, for example access to equipment or possibilities to participate for Swedish industry.

Description of the infrastructure and its activities (maximum 5 pages): The description should only be given for the *specific scientific activities included in the Supplementary grant* and only for the following topics:

- Time schedule,
- construction, development and operations of the infrastructure,
- risk analysis (mitigation plan),

and when applicable

- data handling and requirement for supporting e-infrastructure.

It should be clearly stated which economic and strategic advantages the grant will entail, for example a lower Swedish membership fee to the infrastructure.

Budget: In the budget-template only one section corresponding to one module should be used. The budget should only be presented for *specific scientific activities included in the Supplementary grant*. The budget should also describe how the in-kind contribution is counted in to the Swedish membership.

Key references: Present references that support the participating scientist's scientific merits (CV with a selection, maximum 20, scientific publications).

Support letters: The infrastructure´s call for in-kind contributions or similar and a support letter from the infrastructure concerning the Swedish application should be attached in the appendix "Support letters". The support letter should indicate how the in-kind contribution is counted in to the Swedish membership, when applicable.