Abstract:
This deliverable describes the generated foreground, how it is intended to be used within and beyond this project, including a plan for disseminating the information. The report includes a summary of the technical gaps that remain to be addressed in a follow-up implementation project.
The European Circular Energy-Frontier Collider Study (EuroCirCol) project has received funding from the European Union's Horizon 2020 research and innovation programme under grant No 654305. EuroCirCol began in June 2015 and will run for 4 years. The information herein only reflects the views of its authors and the European Commission is not responsible for any use that may be made of the information.

Delivery Slip

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1. FOREGROUND CREATED

The table in this section lists the foreground knowledge that has been created in the scope of this project for different domains.

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<th>Domain</th>
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<tr>
<td>Particle collider design</td>
<td>A novel, integrated layout and beam optics has been designed for a 100 TeV centre of mass collision proton-proton collider. The feasibility of the optics, the interaction region and functionally relevant insertions (four interaction points, injection, extraction, collimation) has been verified using a diverse set of complementary analytical and simulation tools.</td>
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<td>Vacuum system design</td>
<td>A novel geometry for a beam screen has been designed that can effectively absorb high quantities of synchrotron radiation. STFC (UK) has invented a novel scheme using surface laser treatment with ultrashort pulses that effectively mitigates electron cloud formation in the particle accelerator.</td>
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<td>Superconductivity</td>
<td>With the investment of CERN matching resources, company Bruker (Germany) has under the guidance of CERN significantly improved the current density of the Nb3Sn superconductor. The applied superconductivity group at the University of Geneva (partner in the FCC associated EASITrain H2020 project) has demonstrated that a combination of high upper critical field and enhanced critical current density can be obtained by grain refining in Ta-doped Nb3Sn with internally oxidised Zr. The upper critical field of the samples based on Nb-Ta-Zr alloys exceeds the performance of state-of-the art Nb3Sn conductors. The effect of the transverse load on the performance of Nb3Sn cables and wires was quantified following a successful collaboration with the Universities of Geneva and University of Twente. The conductor development programme that is a direct result of this project attracts companies and laboratories from Europe, Korea, Japan and Russia. Unit lengths of prototype Nb3Sn wires to develop routes to increase the performance and reduce the cost for industrial and healthcare applications beyond the use in research have been produced by companies in this network. During the EuroCirCol final event in June 2019, promising results of developments of project partner Fermilab were presented. There, multi-filamentary wire produced with an internal oxidation process has even exceeded the required target critical current density – reaching values of up to about 1600 A/mm² at 16 T and 4.2 K. The Applied Superconductivity Centre of Florida State University has demonstrated the beneficial influence in improving the high-field performance of Nb3Sn via Hafnium addition to Nb-Ta. University of Geneva has devised early stage concepts to develop a novel superconducting wire with the goal to meet the established performance requirements for a 16 T high-field superconducting particle accelerator magnet.</td>
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<tr>
<td>High field magnet</td>
<td>Under the lead of the Department of Energy (DOE) Fermi National Laboratory (FNAL, Batavia, IL, US), the US partners in this project have designed and built a novel, superconducting high-field magnet for a field reach of 14.5 Tesla. Successful results of these tests were presented during the EuroCircol final event in June 2019. Under the lead of CERN, a collaboration of INFN (Italy) and CEA (France) has developed two concepts for 16 Tesla high field accelerator magnets. CIEMAT (Spain) has developed a novel design for a 16 Tesla high field accelerator magnet. PSI (Switzerland) has developed a novel design for a 16 Tesla high field accelerator magnet. A Swiss nationally funded technology R&amp;D programme (CHART-II) has been defined and kicked-off that integrates a continuation of this work over the coming years. EuroCirCol triggered also the development of a highest field magnet in Russia by the BINP institute. Russian company TVEL, that is part of the international Future Circular Collider (FCC) study is currently developing an advanced Nb3Sn low-temperature superconductor for this magnet development program. The project office has established an international high-field magnet forum to monitor and coordinate these activities after the end of the project period.</td>
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<td>Communication</td>
<td>CERN has developed, built and is currently operating a travelling exhibition called “Code of the Universe” (see <a href="http://codeoftheuniverse.web.cern.ch">http://codeoftheuniverse.web.cern.ch</a>) to raise the public awareness for the need of a future particle-collider based research infrastructure. The exhibition has been developed in cooperation with the EASITRain H2020 project. It has been on show for periods of one to two months in public places in Vienna (Austria), Wiener Neustadt (Austria) and Graz (Austria) in 2018 and in Brussels (Belgium), Grenoble (France) and CERN (Switzerland, on show during the CERN Open Days and on the Esplanade des Particules) in 2019 in cooperation with the EASITRain H2020 project. The panels have been translated from English to German, French and Dutch. Contracted by CERN and the University of Liverpool, UK company Polarmedia has developed three short films to promote the vision of a future particle collider-based research infrastructure. One film focuses on the value and need of international collaboration (“Science knows no borders”). One film deals with the challenges to expand our knowledge horizon (“FCC Expanding our horizons”). One film deals with the societal value of high-tech developments for a particle collider taking the high-field superconducting magnets as an example (“Busy bees and mighty magnets). The films have been used to promote the submission of the study Conceptual Design Report (part of a media package send to 2000 journalists) and footage has been used to cover the new in major media channels (including EuroNews, BBC,</td>
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a.o). The film on “Collaboration” was also shortlisted for the 2019 London’s film awards (EVCOM) among thousands of submissions. Dedicated visits for press/bloggers were organized in collaboration with CERN’s Press Office and contacts have been established in major science communication outlets including Nature Physics/Nature, Scientific American, Forbes, Seeker, The Economist, and others. Given the exploratory nature of a post-LHC facility it is important to establish a global network of science journalists and get them involved in the next steps of the project already at a very early stage.

A communication strategy and plan has been developed that creates the foundation for followup activities to promote the vision of a new particle-collider based research infrastructure. This strategy includes an initial stakeholder list. The four years of the H2020 project permitted testing out communication and engagement concepts with different stakeholder groups. These findings will be key when entering the next design step for the engagement of the different stakeholders.

### Project management

The project has delivered a bottom up cost estimate baseline for a future high field hadron collider, a future high luminosity lepton collider and for an integrated programme consisting of a lepton collider as a first step and a hadron collider as a second step with a program that reaches up to the end of the 21st century.

The project has established an international collaboration of today 137 not-for-profit institutes (universities, research centres) on the basis of a non-committing Memorandum of Understanding. This creation of a geographically distributed and topically complementary group of researchers is the first step towards a consortium for a project preparatory phase.

An international steering committee and an international advisory committee federating domain experts at research centre directorate level have been established. The committees meet regularly to advise on the scope and further priorities of developing the concept for a new research infrastructure and to steer the project such that a world-wide community of future users can be engaged already from this very early feasibility stage onwards.

With the investment of CERN matching resources, work with both host states (France and Switzerland) has started to analyse the necessary administrative processes and to construct working frameworks at a transnational level for developing a feasible placement in the region, an implementation schedule and plan, environmental impact assessment and further implementation relevant topics.
2. GAP ANALYSIS

This section outlines the domains for which gaps towards the next stage, a detailed design and early project implementation preparatory phase have been identified. These gaps need to be addressed with high priority in the next phase.

<table>
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<tr>
<th>Domain</th>
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<tr>
<td>Particle collider design</td>
<td>While for an energy frontier hadron collider the in-principle feasibility has been verified by this project, fitting a highest-luminosity lepton collider in the existing layout would currently only be possible with two interaction points. In addition, the full theoretical performance of such a machine would not be achieved in the current layout. Therefore, the immediate priority would be to revise the current accelerator layout and placement in view of coming to a layout, which fits both particle colliders (proton-proton and electron-positron) well, which can potentially accommodate more than 2 lepton-collider interaction points and which could maybe also be more cost effective (less civil structures for a lepton collider than for a subsequent hadron collider).</td>
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<td>Particle physics experiments</td>
<td>EuroCirCol did not include work on the development of particle physics experiments and detectors at the future collider. With CERN matching resources, a generic hadron collider experiment has, however, been devised. This is an essential activity not only to engage a world-wide community of research infrastructure users, but also to ensure that the collider responds well to the research requirements. The next step is now to form a consortium of potential users who dedicate time to establish proto-collaborations for particle physics experiments, for which concepts need to be developed that respond to specific, documents, physics research goals. Depending on the outcome of the European Strategy for Particle Physics, these proto-collaborations should either focus on hadron- or on lepton collider experiments.</td>
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<tr>
<td>Superconductivity</td>
<td>As expected, it turns out to be a challenge to increase significantly the performance of the Nb3Sn low-temperature superconductor to meet the requirements of a 16 T strong accelerator magnet. Germany company Bruker has advanced the performance, but the conductor is not yet suited for the required magnet development. The international FCC study has established a conductor development program that works with companies in Russia, South Korea, Japan and laboratories in the US, Switzerland and with universities in Germany and Austria to conceive novel approaches to develop a Nb3Sn conductor with a current density of 1500 A/mm² at 16 T strong fields. The in-principle feasibility at laboratory scale exists, but a wire architecture and manufacturing process is not available in the near future. Fundamental research is still needed to demonstrate the performance, to identify a viable route to achieve the</td>
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performance at industrial scale. Consequently, the EuroCirCol consortium has developed and submitted a H2020 MSCA ITN project called EASITrain that has recently been approved. This project is focusing on elucidating the performance and cost limiting factors of high-performance superconductors, advances superconducting thin film technologies and develops a concept for energy efficient cryogenic refrigeration. Economic studies to identify innovation potentials are covered in a dedicated work package.

A highest-luminosity lepton collider in a new, 100 km long tunnel infrastructure opens the possibility to invest into R&D of high-temperature superconductors, which are in high demand by industry for societal applications (material analysis devices, medical imaging devices, energy transport and buffering, motors and wind generators and a plethora of other use cases).

Today, the biggest challenges are to select suitable materials and to develop suitable wires that can be used for high-temperature superconductor-based magnets. An entire new approach to build such magnets and to implement quench protection needs to be developed.

This time scale offers the unique opportunity for co-innovation between academia and industry, to advance that field with the definition of a dedicated and focused HTS magnet R&D programme. Ongoing R&D in this field can advance concurrently with a lepton collider project.

| High field magnet design | This project has confirmed that the design of a 16 T magnet is a significant technological challenge that is today dominated by mechanical and protection topics. First results from tests of a short model prototype currently being built by the EuroCirCol partners in the US shows that the US is about three years ahead in mastering the technology. It takes at least five years to build such a demonstrator model and potentially in the order of 10 years to come to a viable design and full-scale prototype from which series production can be derived.

A highest-luminosity lepton collider in a 100 km long tunnel would open the necessary window of time to continue the high-field magnet development in Europe at a pace that permits coming to a demonstrated design of a 16 Tesla magnet when the time for designing an energy-frontier hadron collider as a second stage comes. Key partners in Europe for the technology have been identified in academia and industry by this project. |

| Radio frequency technology | For any frontier research particle accelerator, highly efficient conversion of electrical to radiofrequency power is key to sustainable operation with respect to energy efficiency and availability (reliability and non-dependence of niche suppliers of powering equipment).

High-capacity klystrons have become a niche market and industrial development has slowed down. Increase of conversion efficiencies |
to reach up to 90% have been demonstrated via simulations of novel designs, but product development is not on the horizon. Cheap and mass-produced solid-state technology is driven by commodity industry, but the per module capacity will remain limited to about 1 kW. Initial large-scale developments have been shown at PSI (Switzerland), at the SOLEIL synchrotron in France and recently in cooperation with Thales (France) at CERN (France/Switzerland). However, the system capacities are still an order of magnitude lower than needed for a future particle collider. Therefore, investments need to be done with industrial partners to integrate commercially available modules using novel, scalable RF power concentrators.

**Technical infrastructures**

Today, large-scale particle accelerators are based on AC electrical distribution systems. The study has revealed that the dependence on the external grid leads to availability downtimes due to grid instabilities (e.g. cryogenics failures due to electricity instabilities in case of thunderstorms elsewhere leading to day- and week-long restore times cause by the significant times needed to liquefy the helium) and make the integration of renewable energy sources difficult. High- and in particular medium voltage DC distribution facilities would de-couple the infrastructure from the grid, leading to potential advantages: increased reliability, possibility to integrate renewable energy sources, cheaper system investment costs due to less and simpler components, possibilities for local energy recovery and buffering and a slight reduction of losses along the distribution chain. Today, industry is not ready to supply such infrastructures in the capacity orders of 20 MW to 50 MW. Hence, a future particle collider would be an ideal case for a development and demonstration test-bed, permitting cross-fertilisation between research and industry.

Work with the host states has revealed the strong interest of the government authorities to make responsible use of water when designing and operating large-scale public infrastructures, including research infrastructures. Water will mainly be required for cooling purposes. Besides moving to high efficiency semi-closed and closed loop cooling systems (already coming into use for new installations at CERN today), an effort needs to be made for the design of a future machine to reduce the water-cooling needs and to reduce the need for evaporation cooling towers, which are also plagued by costly regular maintenance (e.g. legionella treatment).

One investigation to create also added value form the existing infrastructures at CERN, which will not be used during a lepton-collider operation is the study of using inflowing water from the LHC sectors under the Jura mountains instead of losing these resources. The study should aim at elucidating if the water can be tapped, treated, buffered in existing large-scale underground volumes and
transported to other existing infrastructures and new infrastructures to improve the sustainability of the research facility. Also, the possibility to make the resources available for the population in case of need or for limited electricity production should be looked at.

A novel 100 km long underground infrastructure would generate about 10 million cubic-metres of excavation materials. The host states require to study the management of these materials with care, since the topic is part of the environmental impact assessment. Today, final deposit of the material is accepted only as a last resort. The French model of “circular economy” and the absence of adequate deposits in Switzerland (Switzerland already exports today excavation materials from ordinary national infrastructure project construction sites due to the lack of deposits) calls for an immediate, high-priority investigation of ways to make use of the materials.

The topic is of utmost interest to the civil engineering industry and is on top of the European Union Horizon 2020 research and innovation programme, since the problem of excavation materials use is actually a burning one in all European countries.

As a matter of fact, the FCC study has launched in early 2019 a working group federating the Austrian montanistic university Leoben, the French tunnel study center (CETU) and the canton of Geneva earth, soil and waste service to start sketching the roadmap for such investigations towards a construction project.

For a high-energy hadron collider based on low-temperature superconducting magnets, more than 200 MW of sustained electrical energy would be required for liquefying the helium needed to cool the magnets and make them superconducting. Only a novel technology based on a light-gas mixture (neon-helium, a.k.a. nelium) and novel turbocompressors would be able to implement such a system in a cost- and energy efficient way.

The project has launched the design and early stage validation of this technology with CERN matching funds. Today, however, the technology is not demonstrated and not available from industry. Various industrial partners are interested in this technology, ranging from liquid helium and gas companies (Linde, Air Liquide) to machinery companies that are active in the oil & gas sector (e.g. M.A.N. turbo machinery) for their own purposes.

**Project management**

By far the greatest challenge and highest priority today for establishing a project for a new particle-collider based high-energy and particle physics research infrastructure is the need to build a unified and committed user community.

Today, particle physics is at a pivotal point. The discovery of the Higgs boson with its particular characteristics and the experimental observation of phenomena that cannot be explained by the established Standard Model of particle physics have led to a wealth of complementary suggestions for further exploration of nature at its smallest scales. However, consensus exists that only one large-scale
experimental infrastructure can be built by the world-wide science community. Proposals range from an international linear collider in Japan, a linear collider at CERN over numerous small and medium sized experiments at existing facilities to a large-scale, 100 km long particle collider in China to which the European community could contribute with experimental facilities.

The EuroCirCol project has helped creating a critical mass in Europe to put a focus on a long-term European strategy for a particle collider project by developing the best possible, long term research programme in the heart of Europe with the goal to attract the largest possible, world-wide scientist and engineer community in Europe until the end of the 21st century.

Now the immediate next step must be to consolidate this community, to work towards having one vision for a single project in Europe and to establish the proto-collaborations to conceive the experimental facilities at this particle collider infrastructure. Two to four experiments permit crating sustained researcher support from collaborations world-wide with a complementary research program, starting with the in-depth investigation of the Higgs boson and the exploration of the high-energy frontier as the goal for the second half of the 21st century.

The physics community is currently homing in on the view that the full investigation of the Higgs mechanism must be the immediate next step in fundamental physics research. It is considered the portal to new physics that is required to explain the so far enigmatic observations that are the Standard Model cannot explain.

While the EuroCirCol project has delivered a bottom-up analysis of the hadron particle collider, a comprehensive project budget estimate for the entire lifecycle has not yet been established. In particular for the immediate next step, the electron-positron collider, such a budget needs to be established.

The EuroCirCol project has not included the development of a business plan for the funding of the construction and operation of a new particle collider research infrastructure. Based on a more detailed cost estimate, such a plan needs to be drawn up. It also needs to consider the investment profile for the construction and operation phases and develop ways to include contributions from consortium members within the CERN members states, inside and outside Europe beyond the CERN member states.

First investigations of the LHC and HL-LHC research programmes in the FCC study with economics universities and industrial study centres have shown that large-scale physics research facilities produce significant amounts of economic added value beyond the increase of knowledge. These economic values exceed the construction and operation costs by 5 billion CHF in the case of the combined LHC/HL-LHC programme.
While the quantitative impact assessment model used for this analysis is still limited, it has turned out to be a valid instrument for a comprehensive impact assessment that needs to be performed for a future research infrastructure. Such an impact assessment has not been performed yet and the components needed to perform it are still incomplete. Consequently the immediate next steps in close cooperation with competent partners from economics institutes are to
- Establish a complete model for the cost-benefit analysis of a particle-collider based physics research infrastructure
- Gather more detailed quantitative data from the CERN LHC/HL-LHC programme on those elements which have turned out to have the highest economic impact potentials
- Complement those elements for cost-benefit analysis, which have so far not been cast into a quantitative impact assessment model
- Perform a quantitative impact assessment for the first collider project, the high-luminosity lepton collider
- Develop methods and document guidelines for the construction project to increase the impact potentials as much as possible, considering the possibilities to create regional impacts for all participants in such an international endeavor.

The analysis of previous large-scale science projects at CERN and elsewhere led to a set of best-practices for the governance and management structures of a preparatory phase project. These structures are currently in the process of being documented. However, a detailed development of these organisation structures is needed as the next step and the structures need to be implemented in the frame of CERN to establish a working consortium that can efficiently move forward with a detailed design and early project preparatory phase.

Based on the progress in EuroCirCol, CERN has invested matching resources to start working with the host states France and Switzerland for a schedule and plan of the necessary administrative implementation concept in the host states and across the two host states, considering the particular status of CERN as an international organisation. The first analysis of the administrative processes has been documented. However, an integrated process and schedule remains to be developed. In both host states, the schedule aims today for an eight-year lasting preparatory phase, which is considered optimistic. To be able to implement the schedule, a dedicated administrative process project needs to be established and a number of high-priority tasks:
- Develop a process for the declassification of non-constructible zones
| - Develop an integrated framework for the transnational environmental impact management process |
| - Develop an integrated plan for the transnational management of the excavation materials including approaches to increase the use of the materials |
| - Establish a technical risk management framework for the project |
| - Work with the French authorities to achieve the implementation of a law for a single project as was the case for the “Grand Paris” project that permits effectively working towards the construction phase and leverage the uniqueness of the project to help creating added societal and economic value |
| - Work with the Swiss government to explore the use and feasibility of a national sector plan for research infrastructures that permits effectively working towards the construction phase and leverage the uniqueness of the project to help creating added societal and economic value |
| - Prepare all documentation necessary for national political validation of the will to advance with the design of a new research infrastructure and to prepare a construction phase, before a decision to construct is taken (only in this case, the established time schedule can be met) |
3. EXPLOITATION PLAN

This section outlines how the results of the project are disseminated and exploited. This process has already started.

The main deliverable of this project was a conceptual design report. It has been published in December 2018 at the open CERN Document Server (CDS), six months ahead of the scheduled time. Three volumes have been published in the Springer-Nature European Physics Journal Special Topics (EPJ ST) and the physics opportunities document has been published in the Springer-Nature European Physics Journal C (EPJ C). These documents are openly accessible to the worldwide community, serving as a long-term base reference for a future research infrastructure. The figure below shows the download history of the document for the first three months of 2019 (January, February, March).

![Download History Chart](http://fcc-cdr.web.cern.ch)

**Figure 1: Downloads of Conceptual Design Report volumes from http://fcc-cdr.web.cern.ch between January 1 and April 1, 2019**

The figure on the following page highlights the distribution of those countries from which the highest interest, measured in views of the conceptual report volume records comes from. The figure shows that the highest interest stems from the US, China, France, Great Britain and Italy. Although the second largest group comes from Switzerland, these view requests need to be largely attributed to the CERN domain. It is worth pointing out that also measurable interest stems from Turkey. It is astonishing that although Spain and Germany are under the highest ranking interest countries, their share is much less than France and China.
Executive summaries have been produced as input to the European Strategy for Particle Physics. This process is currently ongoing with the goal to develop a consensus-based, coherent plan for the coming five years in Europe for the particle physics landscape. It is worth pointing out that this process includes also contributions from non-European regions. The EuroCirCol consortium members actively participate in this process, ensuring that the results of the project are fully leveraged.

During the project, the lack of a new generation of well-trained lead engineers in the domains of superconductivity and cryogenics has been identified. Consequently, the project consortium members decided to establish a H2020 MSCA project. The EASITRain (European Advanced Superconductivity and Innovation Training Network) proposal has been submitted and has been accepted for funding in 2017. The project is running until June 2021, training a new generation of experts and leaders in fields, which are considered critical for both, a high-energy hadron collider and a high-luminosity lepton collider. During a public event in Vienna (Austria) 2018, relevant persons from EU and EC bodies have been informed about the plan to develop a new large-scale research infrastructure. These persons include R. Heuer (chair of the group of chief scientific advisors to the EC), P. Rübig (MEP and chairperson of EU STOA) and W. Burtscher (deputy director general of DG Research).

The first investigation of socio-economic impacts of the LHC/HL-LHC programme led to encouraging results. Therefore, the project consortium members decided to file together with other partners a H2020 project (RI-Paths) to develop pathways for research infrastructure impact assessment and optimisation. This CSA action is currently ongoing and will help coming to a more homogeneous framework for impact assessment, needed for the next phase of the development of a particle collider-based research infrastructure. EuroCirCol started a series of dedicated workshop with representatives from research organizations and experts working in the field of economics to work on the socio-economic value of investing in fundamental research and how value generation and return to society can be built into a new research infrastructure project from the beginning on.
The first event was co-organized with the EU funded H2020 RI-Paths project and the Belgium Alumni Association of the London School of Economics during the FCCWeek and EuroCirCol final event in June 2019.

This **project has spawned a focused R&D activity on high field superconducting magnets at global scale**. Today, contracts to design and build model magnets have been signed with CEA (France), INFN (Italy), PSI (Switzerland), BINP (Russia), FNAL (US). These activities, funded outside the H2020 programme at levels of more than one million euro each, continue to be active beyond the project period.

This **project has spawned a focused R&D activity on superconducting wires at global scale**. Today the focus lies on Nb$_3$Sn wires together with industrial partners in Germany, Finland, South Korea and Russia. Recently a contract has been established with a Swiss university. US research centres are also performing ground-breaking research, participating in the investigation without formal agreements.

The **EuroCirCol project helped enlarging the Future Circular Collider (FCC) collaboration significantly (137 non-profit institutes from 34 countries)**. The EU project label is generally considered as a sign of high quality and comprehensive project organisation, creating an environment of professionalism and confidence. Thanks to this project, a group of institutes exists today with a much larger scope than the project originally foresaw. This group lives and acts beyond the project duration to prepare now the next phase.

![Figure 3: Map indicating the 137 collaboration member institutes in 34 countries of the Future Circular Collider study. This study coordinates and participates today also in the following H2020 projects: EuroCirCol, ARIES, EASITrain, RI-Paths, FuSuMaTech.](image-url)
The final event of the project took place in Brussels (Belgium) from 24 to 28 June 2019. At the occasion of this event, leading representatives of EU and EC bodies were present (EC DG for Research & Innovation, European Innovation Council and members of the European Parliament) as one of the goals of EuroCirCol was to create an awareness of the need to design and prepare a new research infrastructure project in Europe. For the opening day, representatives of the European Innovation Council (EIC, Carlos Oliveira) and the EC (Keith Sequeira, Senior member of Commissioner Moeda’s Cabinet) offered insights to the participants of the project concerning the need to create value for the society. A dedicated track on the second day focuses on the economics of research infrastructures with M. Boni, MEP - member of European Parliament’s ITRE committee, a representative of EC DG Research (Margarida Ribeiro, EC) and A. Reid (EFIS centre). The conceptual design reports together with executive briefings will also be transmitted after the event to the offices of the relevant EU and EC bodies (e.g. STOA, ESFRI, DG Research, a selected number of commissioners). It is worth pointing out that the French government authority of the Auvergne Rhône-Alpes region has already informed the prefects of the regions and the presidential office about the project scenario and active working links have been created subsequently. At the same time, the Swiss government representatives have been informed in a permanent working group that federates representatives from the Swiss federal department of foreign affairs, the permanent mission of Switzerland at the United Nations and the directorate of the canton and state of Geneva. The latter two governments have now operational relationships with CERN in view of further developing the schedule and plan for a research infrastructure implementation preparatory phase.

The consortium members of EuroCirCol have decided that it is a high priority to submit an EU project proposal for the design of a future highest-luminosity lepton collider, the potential first step in a new 100 km long underground infrastructure. This project would focus on the design of the particle collider (excellent science), the development of the elements that are needed during a preparatory project phase before a decision to build is taken (integrate Europe), the work towards a sustainable research infrastructure by creating a committed scientific user community, the assessment of socio-economic impacts and the development of guidelines on how to achieve high societal impact (leverage and engage). EuroCirCol has shown that innovation is possible along the entire value chain of such a project. Therefore, a project proposal would include the analysis of engagement and innovation capabilities in all of the above mentioned topics.