EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR RESEARCH & INNOVATION

Research infrastructure

ANNEX 1 (part A)

Research and Innovation action

NUMBER — 654305 — EuroCirCol

Table of Contents

1.1. The project summary

Project Number [1]	654305	Project Acronym [2]	EuroCirCol

One form per project

General information	
Project title [3]	European Circular Energy-Frontier Collider Study
Starting date [4]	01/06/2015
Duration in months [5]	48
Call (part) identifier [6]	H2020-INFRADEV-1-2014-1
Topic	INFRADEV-1-2014 Design studies
Fixed EC Keywords	NATURAL SCIENCES, ENGINEERING AND TECHNOLOGY
Free keywords	Particle Physics, Accelerators, Research Infrastructure, International collaboration

Abstract [7]

The award of the 2013 Nobel Prize for Physics acknowledged the leading role of Europe in particle physics, which has a global community of over 10,000 scientists. To reinforce its pole position throughout the 21st century, Europe must be ready to propose an ambitious post-LHC accelerator project by 2018/19. This is one of the main recommendations of the updated European Strategy for Particle Physics, adopted by the CERN Council in May 2013.The EuroCirCol conceptual design study is a direct response to this recommendation, initiating a study for a 100 TeV energy-frontier circular collider through a collaboration of institutes and universities worldwide.A new research infrastructure of such scale depends on the feasibility of key technologies pushed beyond current state of the art. Innovative designs for accelerator magnets to achieve high-quality fields up to 16 T and for a cryogenic beam vacuum system to cope with unprecedented synchrotron light power are required. The effects of colliding two 50 TeV beams must be mastered to meet the physics research requirements. Advanced energy efficiency, reliability and cost effectiveness are key factors to build and operate such an accelerator within realistic time scale and cost.This proposal is part of the Future Circular Collider study under European leadership, federating resources worldwide to assess the merits of different post-LHC accelerator scenarios. It forms the core of a globally coordinated strategy of converging activities, involving participants from the ERA and beyond. Organisations joining this study from Japan and the USA are expected to take part in a global implementation project and a suitable governance model will be drawn-up accordingly.The main outcome of EuroCirCol will be laying the foundation of subsequent infrastructure development actions that will strengthen the ERA as a focal point of global research cooperation and as a leader in frontier knowledge and technologies over the next decades.

1.2. List of Beneficiaries

Project Number [1]	654305	Project Acronym [2]	EuroCirCol

List of Beneficiaries

No	Name	Short name	Country	Project entry month[8]	Project exit month
1	EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH	CERN	Switzerland	1	48
2	TTY-SAATIO	TUT	Finland	1	48
3	COMMISSARIAT A L ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES	CEA	France	1	48
4	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE	CNRS	France	1	48
5	KARLSRUHER INSTITUT FUER TECHNOLOGIE	KIT	Germany	1	48
6	TECHNISCHE UNIVERSITAET DARMSTADT	TUDA	Germany	1	48
7	ISTITUTO NAZIONALE DI FISICA NUCLEARE	INFN	Italy	1	48
8	UNIVERSITEIT TWENTE	UT	Netherlands	1	48
9	CONSORCIO PARA LA CONSTRUCCION, EQUIPAMIENTO Y EXPLOTACION DEL LABORATORIO DE LUZ DE SINCROTRON	ALBA	Spain	1	48
10	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT	CIEMAT	Spain	1	48
11	SCIENCE AND TECHNOLOGY FACILITIES COUNCIL	STFC	United Kingdom	1	48
12	THE UNIVERSITY OF LIVERPOOL	UNILIV	United Kingdom	1	48
13	THE CHANCELLOR, MASTERS AND SCHOLARS OF THE UNIVERSITY OF OXFORD	UOXF	United Kingdom	1	48
14	INTER-UNIVERSITY RESEARCH INSTITUTE CORPORATION, HIGH ENERGY ACCELERATOR RESEARCH ORGANISATION	KEK	Japan	1	48
15	ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE	EPFL	Switzerland	1	48
16	UNIVERSITE DE GENEVE	UNIGE	Switzerland	1	48

1.3. Workplan Tables - Detailed implementation

1.3.1. WT1 List of work packages

WP Number [9]	WP Title	Lead beneficiary [10]	Person-months [11]	Start month [12]	End month [13]
WP1	Management, coordination and implementation	1 - CERN	150.00	1	48
WP2	Arc Lattice Design	3 - CEA	358.00	1	48
WP3	Experimental Insertion Region Design	13 - UOXF	244.00	1	48
WP4	Cryogenic beam vacuum system conception	9 - ALBA	443.00	1	48
WP5	High-field accelerator magnet design	1 - CERN	314.00	1	48
		Total	1,509.00		

1.3.2. WT2 list of deliverables

Deliverable Number [14]	Deliverable Title	WP number [9]	Lead beneficiary	Type [15]	Dissemination level [16]	Due Date (in months) [17]
D1.1	Preliminary collider baseline parameters	WP1	1 - CERN	Report	Public	4
D1.2	Communication and outreach strategy	WP1	1 - CERN	Report	Public	13
D1.3	Collider complex layout and parameters	WP1	1 - CERN	Report	Public	27
D1.4	Plan for use and dissemination of foreground, technical gap analysis	WP1	1 - CERN	Report	Public	41
D1.5	Preliminary Conceptual Design Report	WP1	1 - CERN	Report	Public	47
D1.6	Final report	WP1	1 - CERN	Report	Public	48
D2.1	Overview of arc design options	WP2	3 - CEA	Report	Public	12
D2.2	Overview of collimation concepts	WP2	3 - CEA	Report	Public	18
D2.3	Requirements and constraints of arc design options on WP 3, WP 4, WP 5	WP2	3 - CEA	Report	Public	27
D2.4	Preliminary arc design baseline	WP2	3 - CEA	Report	Public	32
D2.5	Preliminary arc design including optimized and integrated lattice deck	WP2	3 - CEA	Report	Public	44
D2.6	Preliminary collimation system design concept and performance estimate	WP2	3 - CEA	Report	Public	45
D3.1	Overview of EIR design options	WP3	13 - UOXF	Report	Public	15
D3.2	Preliminary EIR design baseline	WP3	13 - UOXF	Report	Public	29
D3.3	Preliminary EIR design including optimized lattice deck	WP3	13 - UOXF	Report	Public	44
D4.1	Analysis of vacuum stability at cryogenic temperature	WP4	9 - ALBA	Report	Public	22

Deliverable Number [14]	Deliverable Title	WP number [9]	Lead beneficiary	Type [15]	Dissemination level [16]	Due Date (in months) [17]
D4.2	Measurements of vacuum chamber at light source	WP4	9 - ALBA	Report	Public	28
D4.3	Preliminary beam screen and beam pipe engineering design	WP4	9 - ALBA	Demonstrator	Public	29
D4.4	Analysis of beam-induced vacuum effects	WP4	9 - ALBA	Report	Public	36
D5.1	Overview of magnet design options	WP5	1 - CERN	Report	Public	17
D5.2	Identification of preferred dipole design options and cost estimates	WP5	1 - CERN	Report	Public	26
D5.3	Cost model for dipole magnet	WP5	1 - CERN	Report	Public	39
D5.4	Manufacturing folder for reference design dipole short model	WP5	1 - CERN	Demonstrator	Public	46

1.3.3. WT3 Work package descriptions

Work package number [9]	WP1	**Lead beneficiary** [10]	1 - CERN
Work package title	Management, coordination and implementation		
Start month	1	**End month**	48

Objectives

1) Manage the H2020 study project and integrate it coherently with the FCC study
2) Produce hadron collider Conceptual Design Report
3) Assure quality of the deliverables
4) Coordinate work packages at technical and scientific level and maintain the technical scope
5) Coordinate hadron collider baseline parameter refinement and
6) Develop an overall layout and plan for the collider infrastructure
7) Ensure a coordinated flow of information between project, industry, universities
8) Plan and implement outreach and communication activities
9) Plan and perform gender and equal opportunities relevant activities
10) Explore innovation potentials and transfer to society, and in particular industry
11) Develop implementation scenarios including management and governance structures
12) Develop a cost baseline for the collider infrastructure

Description of work and role of partners

WP1 - Management, coordination and implementation [Months: 1-48]
CERN, UNILIV
Task 1.1: Study management (CERN)
The project coordinator CERN oversees and co-ordinates the work of all work packages, to ensure consistency of the work according to scope definition and to manage the planned resources. Critical activities at the very beginning are to integrate the H2020 study with the FCC study, to install all bodies that are required for the governance and execution of the project. This task will also produce the main deliverable of the study, the Conceptual Design Report (D-1.7) of the hadron collider. The following activities make up the management task of the study:
• Establish the project plan (work breakdown, organisation, resource estimation and allocation, project schedule and study project risk management)
• Maintain consistency of work in terms of work package coverage avoiding duplication and non-coverage, project tracking and auditing in terms of scope, schedule and cost evolution
• Organise internal reviewing. Identify, plan, initiate and verify corrective actions
• Follow-up of deliverable production and verification against defined goals
• Administrative, financial and contractual follow-up of the project, according to the EC Grant Agreement and its annexes. Distribute EC funding, control resource utilisation, report internal cost. Collect, review and submit the Certificates on the Financial Statements by the beneficiaries.
• Produce Conceptual Design Report

Task 1.2: Quality management (CERN)
CERN establishes and applies a QM process based on the quality framework established for the FCC study. It covers also the preparation of the periodic and final activity reports and the formal checking of deliverable and milestone reports. In particular, the task includes the following activities:
• Establish a quality system for the study, the managerial, scientific and technical documentation
• Provide tools that the consortium uses to manage the deliverables
• Inform participants about applying quality methods
• Prepare internal and external progress and deliverable reports (D-1.3, D-1.5, D-1.8, D-1.9)
• Verify work package reports and make them available to participants and governance bodies

Task 1.3: Communication, dissemination and outreach (UNILIV, CERN)
UNILIV coordinates the communication, information dissemination and outreach activities. It will in cooperation with the consortium organise project internal meetings and organise outreach events. A key activity is the development of a communication and outreach strategy, which targets a wider scientific community, the public and decision making bodies (D-1.2). Professionally produced information material and media will be distributed via participants and at

events to promote the study's activities and impacts. This will be part of a wider communication plan, which will be formalised following agreement at the kickoff meeting under the leadership of UNILIV. It will review results to identify material appropriate for general dissemination and will work with partners to achieve international coverage. Partners committed to delivering specific outreach activities as part of their work will contribute to project-wide outreach events at venues across the consortium. The project will be represented at established external outreach events such as the Big Bang Fair in the UK and the Euro Science Open Forum, and will be promoted through a dedicated outreach symposium and participant open days. Together with the support from CERN's EU office, UNILIV's dedicated team will disseminate technical and scientific information via newsletters, the project web site, as well as CERN's document management systems. UNILIV's media services and press office will work with the CERN communications and press offices concerning public information and relations with press and media. Specifically, this task includes the following activities:
• Organize annual meetings, public and industry events, project internal workshops
• Organize information events for funding agencies and decision making bodies
• Develop an outreach package, including leaflets and a glossy brochure with key research results for international distribution and relevant media contacts
• Set up and maintain a project web site and targeted mailing lists
• Disseminate research results via Web contents systems, newsletter and social media platforms
• Prepare technical information targeting higher education institutions and industry
• Establish and maintain relations with international and corporate press and media

Task 1.4: Knowledge and innovation management (CERN)
A major goal is to identify, which innovations generated by the work packages can be transferred to society, and in particular, to industry. If built, the large-scale collider infrastructure will generate high-volume industry contracts and boost industrial developments in various high-tech domains. Therefore, another goal is to prepare the grounds for a long-term industrialization plan in view of construction and operation phases. These goals require active technology scouting, identifying those technologies that can find applications in fields other than accelerators and which can serve as pilots for large-scale industrialization (D-1.6). Medical, life-sciences, safety and mechatronics applications are of primary interest. Potential followup industrialization and dedicated R&D programs, which are of particular interest for industry in the coming decade will be identified. Performing the tasks of this work package requires networking at several levels: Communication with all participants is mandatory throughout the entire duration of the project to identify key areas that can be the subject of technology transfer. To this end, each WP nominates a KT representative who meets regularly with the CERN KT office. Existing networks will be used as tools of information dissemination to all the stakeholders, namely:
• the partners of this project and other relevant projects (e.g. HiLumi LHC DS, EuCARD2, TIARA-PP);
• all industrial partners who might be potentially interested;
• the scientific accelerator community and scientific policy making bodies in coordination with the outreach and communication task
• the general public and media in coordination with the outreach and communication task
A particular event is planned to bring together the consortium and interested industrial partners to explore the technologies developed in the framework of the project. The KT office will request and assess feedbacks from industrial partners, following the technical development and evolution of the component designs. The annual meetings will feature dedicated tracks on this topic, thus facilitating the bonding between industry and science.

Task 1.5: Coordinate technical scope (CERN)
The main goals of this task are to ensure a coherent evolution of the overall collider design and key parameters and to maintain consistency of the technical work carried out by the individual work package with the overall design goals (D-1.1). For this purpose, CERN chairs the parameter committee, which regularly updates the baseline parameters based on input from individual work packages and in agreement with the activities of the overall FCC study. It will communicate the agreed baselines to all members of the Consortium and ensure that all key contributors are aware of updates. The task includes the definition of the machine layout in agreement with physics goals and findings (D-1.4), CERN injector and physics program requirements, infrastructure requirements and constraints, such as findings from geology studies, health-safety and environmental aspects, overall operation and cost factors. This task constitutes a major interface between the FCC study and the H2020 project.

Task 1.6: Develop implementation and cost scenarios (CERN)
To develop an overall cost scenario for the infrastructure as part of the CDR (D-1.7), CERN will integrate cost models developed in the FCC study and in the H2020 project. Baseline parameters and constraints delivered by task 1.5 will be tuned to find a good ratio between physics performance, flexibility, extensibility and cost of construction and operation. A product breakdown structure that lies at the heart of the cost model, serves as a starting point for

drafting an implementation scenario, considering international distribution of science and engineering skills, production capabilities, evolution of human resources and geographical well-balanced distribution of work. An appropriate governance structure for a global collaboration model will be developed. A gap analysis will reveal a number of scientific, technical, engineering and managerial issues that will need to be addressed in a follow-up pre-construction phase. One major aspect will be the identification of long-term industrialization needs that should lead to a number of partnerships for specific development projects with industry.

Participation per Partner

Partner number and short name	WP1 effort
1 - CERN	128.00
12 - UNILIV	22.00
Total	150.00

List of deliverables

Deliverable Number [14]	Deliverable Title	Lead beneficiary	Type [15]	Dissemination level [16]	Due Date (in months) [17]
D1.1	Preliminary collider baseline parameters	1 - CERN	Report	Public	4
D1.2	Communication and outreach strategy	1 - CERN	Report	Public	13
D1.3	Collider complex layout and parameters	1 - CERN	Report	Public	27
D1.4	Plan for use and dissemination of foreground, technical gap analysis	1 - CERN	Report	Public	41
D1.5	Preliminary Conceptual Design Report	1 - CERN	Report	Public	47
D1.6	Final report	1 - CERN	Report	Public	48

Description of deliverables

D1.1 : Preliminary collider baseline parameters [4]

This deliverable provides a preliminary specification of the layout and target operation parameters for the hadron collider. They serve as starting point for the studies in all work packages.

D1.2 : Communication and outreach strategy [13]

In addition to the general QA, publication and communication plan, which is oriented towards project internal communication, this detailed plan describes the envisaged communication and outreach strategies towards project external audiences. It includes policy and decision takers, other scientists, industry and the public. It will consider country, culture, language and gender specifics.

D1.3 : Collider complex layout and parameters [27]

This deliverable describes the preferred layout and target operation parameters for the hadron collider. They serve as input for the consolidation of arc and interaction region design studies as well as all dependent FCC infrastructure studies, which are outside the scope of this EC research activity.

D1.4 : Plan for use and dissemination of foreground, technical gap analysis [41]

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 followup implementation project.

D1.5 : Preliminary Conceptual Design Report [47]

The preliminary CDR serves the CB to recommend to the CERN Council subsequent technical R&D activities for a pre-project phase. This version of the CDR is part of a set of documents being prepared for the next European Strategy for Particle Physics Update.

D1.6 : Final report [48]

This deliverable provides a summary of the work and achievements over the entire project duration. A public version of the report will be made available online.

Schedule of relevant Milestones

Milestone number [18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS1	Web site available	1 - CERN	2	A web site with general information on the project, the management and governance structure, the work package descriptions and primary contact persons has been established. The site address has been released to the Consortium members.
MS2	EuroCirCol Kick-off Meeting	1 - CERN	3	The Kick-off meeting giving an overview of the project, establishing a working management and governance structure has taken place. Minutes of the executive management group have been approved and the work plan has been agreed.
MS7	QA, publication and communication plan	1 - CERN	6	A plan describing the quality management processes and systems used in the scope of the study has been established and has been released on the document management system, which can be used by all Consortium members. The document includes a communication

Schedule of relevant Milestones

Milestone number [18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
				plan, which captures the communication and outreach strategy considering the identified target audiences.
MS11	Annual Report	1 - CERN	12	At the end of the first twelve months, each Beneficiary provides input for an interim activity report about the work performed in the tasks of all work packages, achievements, problems encountered and corrective actions taken as well as any major deviations from the original work description. The report includes an assessment of the project situation and any expected delays for the coming period.
MS12	Collider baseline parameters	1 - CERN	12	An annotated description of the hadron collider baseline layout and operation parameters, which serves as a baseline of work for design optimisation work.
MS14	1st Annual Collaboration Meeting	1 - CERN	15	In the scope of the annual meeting report on progress, showstoppers and findings in the form of selective workshop presentations. Management and governance bodies of the project review the progress. The approved minutes of the bodies will be made available to the Consortium members and appropriate news coverage will be performed via the channels identified in the communication plan.
MS18	2nd Annual Collaboration Meeting	1 - CERN	27	In the scope of the annual meeting report on progress, showstoppers

Schedule of relevant Milestones				
Milestone number [18]	**Milestone title**	**Lead beneficiary**	**Due Date (in months)**	**Means of verification**
				and findings in the form of selective workshop presentations. Management and governance bodies of the project review the progress. The approved minutes of the bodies will be made available to the Consortium members and appropriate news coverage will be performed via the channels identified in the communication plan.
MS19	Outreach package	1 - CERN	28	Produce a set of outreach artefacts as identified in the communication plan. The package will be published at the next possible Consortium meeting and will be announced to the public via the identified communication channels.
MS22	Implementation and governance model	1 - CERN	37	Description of management and governance structures, which would be suitable for a construction phase of a large-scale, collider-complex based research infrastructure for high-energy particle physics.
MS24	3rd Annual Collaboration Meeting	1 - CERN	39	In the scope of the annual meeting report on progress, showstoppers and findings in the form of selective workshop presentations. Management and governance bodies of the project review the progress. The approved minutes of the bodies will be made available to the Consortium members and appropriate news coverage will be performed via the

Schedule of relevant Milestones

Milestone number [18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
				channels identified in the communication plan.
MS30	Cost baseline	1 - CERN	46	Overall Product Breakdown Structure of the collider indicating quantities and costs with an indication of how to parameterize the cost overview in presence of evolving material, production and commodity resource costs and the constitution of a potential consortium for the realization of such a large-scale research infrastructure for high-energy particle physics.
MS31	Industry and outreach event	1 - CERN	46	Report on a dedicated event bringing together potential partners from industry and informing different identified target audiences about the advancement of the design for a next generation, collider complex based large-scale research infrastructure for high-energy particle physics.
MS37	Closing event	1 - CERN	48	Present the summarized achievements of the study and the planned dissemination actions in form of a scientific workshop with plenary and parallel track presentations. Give students the opportunity to show their work to the scientific audience. Present and discuss planned actions, which can follow this project as preparatory phase action towards a construction phase with targeted technical R&D activities.

Work package number [9]	WP2	Lead beneficiary [10]	3 - CEA
Work package title	Arc Lattice Design		
Start month	1	End month	48

Objectives

The objective is to design an overall cost/performance optimized arc:
1) Develop an optimised conceptual design of the hadron collider arc
2) Evaluate and optimise the dynamic aperture and magnet field quality tolerances
3) Develop a baseline conceptual design of the collimation sections
4) Provide the key functional specifications for the beam pipe and magnets

Description of work and role of partners

WP2 - Arc Lattice Design [Months: 1-48]
CEA, CERN, CNRS, TUDA, KEK
The arcs and their magnets make up the largest fraction of the collider. Their design is critical for beam stability and determines the overall cost. In particular, magnet aperture affects cost and constrains the field achievable field quality. Detailed studies including iterative optimisation of the beam pipe are carried out, to come to a model that allows tuning performance yield vs. cost. To achieve the required breakthrough, the work considers novel design approaches, such as high temperature superconductor coatings. The integration of the insertions and the magnet tolerances are also covered here.

Task 2.1: Work Package Coordination (CEA, CERN)
CEA with the assistance of CERN coordinates the work of all other tasks of this WP to ensure consistency of the work according to the project plan and to coordinate the WP technical and scientific scope with the tasks carried out by the other WPs. Coordination duties include the organization of WP internal steering meetings, setting up of proper reviewing, reporting to project management and distribution of the information within the WP as well as to the other work packages. The task also covers the organization the annual meeting sessions dedicated to the WP activity review and possible workshops or specialized working sessions, implying the attendance of invited participants from inside and outside the consortium. In particular this WP requires coordination with other WPs on the following subjects:
• WP 3 (experimental insertion region design): Integrate the interaction region design with the collider ring and give feedback on dynamic aperture, impedance and electron cloud effects. Closely collaborate on the collimation system design and the interaction region design.
• WP 4 (cryogenic beam vacuum system design): Evaluate the impedance of the different possible beam pipe designs and the impact on the beam. Verify that electron cloud effects are understood by comparing the findings to the measurements performed at the light-source and verify that proposed mitigation measures are effective.
• WP 5 (accelerator magnet design): Provide appropriate field error tolerance constraints to accelerator magnet designers as requirements, understand technical limitations emerging during the magnet design studies and incorporate the feedback as constraints into the beam optics optimisation studies.

Task 2.2: Develop optimised arc lattice (CEA, CERN)
CEA in its leading role will explore different arc optics design options (D-2.1) and compare them in terms of performance and cost. Together with CERN, CEA will iteratively develop one optimised design baseline to adjust tolerances for the magnet field errors by adding non-linear elements (D-2.4, D-2.5). The work will be performed in close collaboration with task 2.3 (dynamic aperture) and WP 5 (accelerator magnet design), to commonly establish acceptable field error tolerances for different magnet designs.

Task 2.3: Study dynamic aperture (CEA, CERN)
The dynamic aperture depends on the magnetic field quality and defines the effective space available for the beam in the collider. It has a strong impact on the beam loss rate. At injection it is mostly limited by the arcs and at collision energy by the interaction regions. CEA and CERN will integrate the key optics lattice designs of the different parts of the collider ring into a single unit, in particular from tasks 3.2 and 2.5. CEA will then assess the available dynamic aperture for the beam at injection and collision energies. This will be done for different design options and as a function of the working point, i.e. the total phase advance around the ring, considering the magnet field errors. Based on the results, CEA will give guidance to the optics design tasks to improve the designs. The rate of particles diffusing into

the halo to be collimated will be estimated in close collaboration with task 3.3 and 2.5. Resulting design requirements and constraints will be documented (D-2.3).

Task 2.4: Study single beam current limitation (TUD, CERN)
Interaction of beam particles with the collider ring hardware and between particles in the same beam can cause the beam to become unstable. The most critical issue is impedance of the collider ring. TUD will determine the impedances of the key hardware components of the machine, in particular the beam screen and collimation system, and will simulate the impacts of these impedances and other single beam collective effects on the beam. It will then propose beam instability mitigation methods, in particular bunch-to-bunch feedback. At injection, the most critical issues according to LHC experience will be the impedance of the arc beam pipe. This effect will be studied in close collaboration with WP 4 (cryogenic beam vacuum system design). Similarly, at collision energy the most important impedance is that of the collimators, which will be studied in close collaboration with task 2.6. Resulting design requirements and constraints will be documented (D-2.3).

Task 2.5: Understand and control impact of electron cloud effects (KEK, CERN)
Different processes produce free electrons in the beam pipe. The fields of passing bunches can kick them into the beam pipe where they produce larger numbers of secondary electron leading to a build-up of an electron cloud, which heats the beam pipe and can render the beam unstable. KEK with the support of CERN will study the generation of electron clouds by photo production and multipacting. In particular they will simulate the build-up for different geometric designs of the beam pipe, for different surface coatings and for different beam configurations. This will be done in close collaboration with WP 4 (cryogenic beam vacuum system). KEK will evaluate the fitness of different coating materials and will propose methods to mitigate the electron cloud effect. Together with CERN, KEK will analyse the findings on the overall beam optics developments and consequently on the beam pipe design. Resulting design requirements and constraints will be documented (D-2.3).

Task 2.6: Develop optics concept for collimation system (CNRS, CERN)
The collimation system has to keep the beam induced energy deposition in the arc magnets below the acceptable level to avoid that the superconducting magnets quench and to protect the experiments from background. The generated impedance has to be within acceptable limits, too. CERN will specify the optics requirements for the collimation system. This requires the development of a collimation strategy and studies of the collimator robustness (D-2.2). CNRS will design the optics lattice of the collimation system insertions and will integrate the other collimators into the optics of the collider ring. CERN will perform tracking studies to determine residual particle losses due to system inefficiency. CERN will also simulate the development of particle showers in the machine components in order to verify that the power density in the superconducting magnets stays below the quench limit and to determine the lifetime limitation of key elements and the generation of background. The work will be carried out in close collaboration with task 2.4 to ensure that the collimation system impedance is acceptable for the beam. Working hand-in-hand with tasks 3.2, 3.3 and 2.2 the performance will be evaluated and optimised for the experiments and the magnets of the arc (D-2.6).

Participation per Partner

Partner number and short name	WP2 effort
1 - CERN	90.00
3 - CEA	108.00
4 - CNRS	64.00
6 - TUDA	84.00
14 - KEK	12.00
Total	358.00

List of deliverables

Deliverable Number [14]	Deliverable Title	Lead beneficiary	Type [15]	Dissemination level [16]	Due Date (in months) [17]
D2.1	Overview of arc design options	3 - CEA	Report	Public	12
D2.2	Overview of collimation concepts	3 - CEA	Report	Public	18
D2.3	Requirements and constraints of arc design options on WP 3, WP 4, WP 5	3 - CEA	Report	Public	27
D2.4	Preliminary arc design baseline	3 - CEA	Report	Public	32
D2.5	Preliminary arc design including optimized and integrated lattice deck	3 - CEA	Report	Public	44
D2.6	Preliminary collimation system design concept and performance estimate	3 - CEA	Report	Public	45

Description of deliverables

D2.1 : Overview of arc design options [12]

Description of arc design options and collider layouts to be taken into consideration for further detailed studies. Summary of the relative merits, requirements, constraints and impacts of each of the options to be considered. Classification according to estimated value and realization risk.

D2.2 : Overview of collimation concepts [18]

Description of collimation system concept options to be taken into consideration for further detailed studies. Summary of the relative merits, requirements, constraints and impacts of each of the options to be considered. Classification according to merit and realization risk.

D2.3 : Requirements and constraints of arc design options on WP 3, WP 4, WP 5 [27]

Estimates of requirements and limitations imposed by the options onto magnet field levels and qualities, intensity and energy limitations and physical constraints onto the experimental insertion region and onto the cryogenic beam vacuum system.

D2.4 : Preliminary arc design baseline [32]

Description of the arc baseline design including a list of beam-line elements (type, description, quantity, physical element characteristics). Description of the assumptions taken, requirements and constraints imposed onto the infrastructure and infrastructure services.

D2.5 : Preliminary arc design including optimized and integrated lattice deck [44]

Annotated beam optics and lattice files with specifications of the required magnet parameters (strengths and apertures) including consolidated position and element characteristics. Specification of the required magnet types and quantities including magnet field quality specifications.

D2.6 : Preliminary collimation system design concept and performance estimate [45]

Description of the collimation system baseline design including a list of beam-line elements (type, description, quantity, physical element characteristics). Description of the assumptions, requirements and constraints on the infrastructure and services. Summary of the expected performance.

Schedule of relevant Milestones

Milestone number [18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS3	WP2 group established and hiring complete	3 - CEA	5	The working group covering WP2 (Arc Lattice Design) has been formed, WP and task leaders have been identified and technical staff has been appointed.
MS9	Preliminary arc optics and lattice files	3 - CEA	11	Produce preliminary arc optics in the form of lattice files to provide a baseline for dynamic aperture and magnet design studies. The files will be made available on the project's document management system.
MS21	Arc key component functional design specifications for preliminary baseline	3 - CEA	35	Report on the list of key accelerator elements for the accelerator arc and their functional design properties, based on the existing preliminary arc design baseline. The report indicates also the foreseen quantities so to permit coming to an accelerator overall cost estimate.
MS25	Analysis of electron cloud effects and mitigation options	3 - CEA	40	Report on the results of the electron cloud effects studies using computer simulations, considering different geometric designs of beam pipe, different surface treatments and different beam configurations. Assessment of coming to a workable system for a preferred set of working points and resulting requirements and constraints on the overall collider design.
MS27	Consolidated arc design baseline	3 - CEA	41	Report on the collider arc design and its key

Schedule of relevant Milestones

Milestone number [18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
				elements considering the cumulative findings of all studies carried out so far, usable as input for the preparation of the Conceptual Design Report.
MS33	Report on recommended accelerator follow-up R&D	3 - CEA	47	Gap analysis between findings of the study, towards a realization project: Portfolio of suggested R&D topics related to accelerator technologies and design elements remaining to be elaborated in greater detail or to be further optimised to come to a sustainable machine design.

Work package number [9]	WP3	Lead beneficiary [10]	13 - UOXF
Work package title	Experimental Insertion Region Design		
Start month	1	**End month**	48

Objectives

The experimental insertion region hosts the detectors. Its design is critical to achieve the required luminosity and to control the beam background conditions for the experiments. The main goal is to optimise the luminosity per beam current, ensuring that beam induced radiation does not compromise the experiments and adversely affect collider operation. The following objectives are set:
1) Develop a baseline conceptual design of the interaction region, consistent with machine and detector requirements
2) Specify functions and performances of key beam-line elements
3) Develop a machine detector interface concept
4) Identify the potential needs for further dedicated research and development activities

Description of work and role of partners

WP3 - Experimental Insertion Region Design [Months: 1-48]
UOXF, CERN, INFN, STFC, EPFL
The design of the experimental insertions is challenging due to the unprecedented beam energies and powers at high luminosity. Achieving a small beta-function will improve the ratio of luminosity to circulating beam current, the latter leading to machine protection challenges and strong synchrotron radiation. The insertion region design has to be consistent with the needs of the experiments to perform physics research and with sustainable collider operation. Its design must cope with the high power of protons coming from the interaction point.

Task 3.1: Work Package Coordination (UOXF, CERN)
UOXF with the assistance of CERN coordinates the work of all other tasks of this work package to ensure consistency of the work according to the project plan and to coordinate the WP technical and scientific scope with the tasks carried out by the other WPs. Coordination duties include the organization of WP internal steering meetings, setting up of proper reviewing, reporting to project management and distribution of the information within the WP as well as to the other work packages. The task also covers the organization the annual meeting sessions dedicated to the WP activity review and possible workshops or specialized working sessions, implying the attendance of invited participants from inside and outside the consortium. In particular this WP requires coordination with other WPs on the following subjects:
• WP 2 (arc design and lattice integration): WP 2 will integrate the insertion region design into the overall design and evaluate its impact on dynamic aperture and beam stability, which have to be taken into account in WP 3. WP 2 will provide input on the expected beam loss in the interaction region from the collimation system.
• WP 5 (accelerator magnet design): Understand the technical limits of the magnets that are relevant for the interaction region design.

Task 3.2: Develop interaction region lattice (UOXF, CERN)
UOXF will coordinate this task. UOXF and CERN will develop the collision optics using different approaches in order to identify the best solution applying an iterative approach (D-3.1, D-3.2, D-3.3). The aim is to achieve small transverse beam sizes at collision energy to obtain high luminosity at limited beam current. This will take into account limitations from the magnet performance and non-linear optics effects, consider boundary conditions arising from the radiation estimated in task 3.3 (machine detector interface) and beam-beam interactions (task 3.4). This task includes the development of the interaction region optics at injection and ramping to collision energy, requiring verification for a smooth transit from injection optics to collision optics. The task will provide important input for the choice of beam current and will define boundaries for the accelerator magnet design, identifying key cost and performance drivers.

Task 3.3: Design machine detector interface (STFC, INFN and CERN)
STFC will coordinate this task and will study the machine detector interface to ensure that the collider design is consistent with the detector performance. In particular, STFC will determine the required apertures for the detector and integrate detector components into the interaction region optics as required, e.g. foresee a detector to determine the total luminosity. Together with CERN, STFC will evaluate the impact of the debris from the collimation system on the interaction region and will optimise this system together with task 3.5. INFN and STFC will study the impact of synchrotron radiation emitted by protons on detector and machine components in the interaction region and develop mitigation techniques. The colliding beams in the interaction point produce a large amount of debris that can destroy the

magnets close to the detector. CERN will simulate this source of radiation and develop shielding concepts to protect the machine in close collaboration with optics design work in task 2.2 (Interaction region lattice design). Space constraints for experimental detectors will be derived and documented as part of the overall baseline design parameters (task 1.5).

Task 3.4: Study beam-beam interaction (EPFL, CERN)
The colliding high-energetic beams can lead to instabilities and even beam loss. There is direct interaction of the colliding bunches and indirect interaction when bunches of one beam entering the experimental area come close to bunches of the other beam leaving it. EPFL with support from CERN will study those effects. EPFL will simulate the dynamic aperture and instabilities in the presence of beam-beam collisions for different design options. In particular, EPFL will study round and flat beam options and identify the acceptable limit to the beam-beam interaction with different bunch time structures. Different methods to reduce the impact of beam-beam interactions will be explored, e.g. wire compensation schemes, electron lenses and crab cavities. Potential interactions of beam-beam effects with impedance related beam instabilities will be identified and explored. These studies will give lead to a selection of preferred circulating beam currents and crossing angles at the interaction point. Based on this, the required characteristics for the various different collider subsystems can be adjusted.

Participation per Partner

Partner number and short name	WP3 effort
1 - CERN	42.00
7 - INFN	30.00
11 - STFC	48.00
13 - UOXF	88.00
15 - EPFL	36.00
Total	244.00

List of deliverables

Deliverable Number [14]	Deliverable Title	Lead beneficiary	Type [15]	Dissemination level [16]	Due Date (in months) [17]
D3.1	Overview of EIR design options	13 - UOXF	Report	Public	15
D3.2	Preliminary EIR design baseline	13 - UOXF	Report	Public	29
D3.3	Preliminary EIR design including optimized lattice deck	13 - UOXF	Report	Public	44

Description of deliverables

D3.1 : Overview of EIR design options [15]
Description of EIR design options and collider layouts to be considered for further detailed studies. Summary of the relative merits, requirements, constraints and impacts of each of the options to be considered. Classification according to estimated value and realization risk.

D3.2 : Preliminary EIR design baseline [29]
Description of the EIR baseline design including a list of beamline elements (type, description, quantity, physical element characteristics). Estimates of the achievable performances at the interaction points. Description of the assumptions taken, requirements and constraints imposed onto the infrastructure and infrastructure services.

D3.3 : Preliminary EIR design including optimized lattice deck [44]

Annotated beam optics and lattice files with specifications of the required magnet parameters (strengths and apertures) including consolidated position and element characteristics. Specification of the required magnet types and quantities including magnet field quality specifications.

Schedule of relevant Milestones

Milestone number [18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS4	WP3 group established and hiring complete	13 - UOXF	5	The working group covering WP3 (Experimental Insertion Region Design) has been formed, WP and task leaders have been identified and technical staff has been appointed.
MS10	Preliminary EIR optics and lattice files	13 - UOXF	11	Produce preliminary optics for the experimental insertion region in the form of lattice files to provide a baseline for studying radiation effects, machine detector interface and beam-beam interactions as well as an optimised design for a smooth transit from injection to collision optics. The lattice files will be made available on the project's document management system.
MS17	Requirements and constraints of EIR design options on WP 2, WP 4, WP 5	13 - UOXF	23	Description of Experimental Insertion Region design options and their impacts onto arc design, cryogenic beam vacuum and magnet design in terms of relevance and potential realization risk and cost will be made available on the project's document management system.
MS23	EIR key component functional design specifications for preliminary baseline	13 - UOXF	38	Report on the list of key accelerator elements for the collider experimental insertion region and its functional design properties, based on the existing preliminary EIR design baseline.

Schedule of relevant Milestones

Milestone number [18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
				The report indicates also the foreseen quantities and constraints on the infrastructure (e.g. experiment cavern and machine-detector-interface elements) so to permit coming to a overall cost estimate of the collider.
MS26	Report on design option for machine detector interface	13 - UOXF	40	Report on the machine-detector-interface requirements and constraints considering all studies carried out so far. Report on the impact of synchrotron radiation on detector and machine components in the interaction region and on the effects of debris onto magnets close to the detector. Report on radiation shielding and space constraints for experiments.
MS28	Consolidated EIR design baseline	13 - UOXF	41	Report on the collider Experimental Insertion Region design and its key elements considering the cumulative findings of all studies carried out so far, usable as input for the preparation of the Conceptual Design Report.
MS34	Report on recommended collider follow-up R&D	13 - UOXF	47	Gap analysis between findings of the study, towards a realization project: Portfolio of suggested R&D topics related specifically to the interaction point, experimental area and machine detector interface design elements remaining to be elaborated in greater detail or to be further optimised to come to

Schedule of relevant Milestones

Milestone number [18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
				a sustainable machine design.

Work package number [9]	WP4	Lead beneficiary [10]	9 - ALBA
Work package title	Cryogenic beam vacuum system conception		
Start month	1	End month	48

Objectives

1) Evaluate the impact of the arc design on technology requirements
2) Develop an overall, integrated design for the cryogenic beam vacuum system consisting of (1) beam screen, (2) proximity cryogenics, (3) magnet cold bore and (4) vacuum system
3) Determine the needs for advancing individual technologies to meet the requirements
4) Study synchrotron radiation heat load absorption and mitigation of the photo-electrons generation
5) Consider novel mitigation techniques, e.g. based on frequent discrete photon absorbers

Description of work and role of partners

WP4 - Cryogenic beam vacuum system conception [Months: 1-48]
ALBA, CERN, KIT, INFN, CIEMAT, STFC
The cryogenic beam vacuum system for the arc dipoles will be designed in close iterative interaction with the magnet cold bore conceptual design. The functional and performance requirements need therefore to be continuously re-evaluated and refined. Relevant aspects include beam-induced heat loads including synchrotron radiation, vacuum stability, mechanical performance, beam screen cooling concept, dynamic effects such as electron cloud multipacting and photo-electrons generation by synchrotron radiation. Image current continuity and impedance are assumed to significantly affect the accelerator and magnet design. Optimisation has large performance improvement and cost reduction potentials.

Task 4.1: Work Package Coordination (ALBA)
ALBA with the assistance of CERN coordinates the work of all other tasks of this work package to ensure consistency of the work according to the project plan and to coordinate the WP technical and scientific scope with the tasks carried out by the other WPs. Coordination duties include the organization of WP internal steering meetings, setting up of proper reviewing, reporting to project management and distribution of the information within the WP as well as to the other work packages. The task covers the organization the annual meeting sessions dedicated to the WP activity review and possible workshops or specialized working sessions, implying the attendance of invited participants from inside and outside the consortium. In particular this WP requires coordination with other WPs on the following subjects:
• WP 2 (arc design and lattice integration): Task 4.2 relies on layout and design parameters for modelling and creating a conceptual design of the cryo-photon absorbers. Task 4.6 provides input on adjusting the overall beam parameters based on the measurement results.
• WP 5 (accelerator magnet design): Task 4.2 needs to ensure compatibility between the conceptual design of the cryo-photon absorbers and the accelerator magnet design. Task 4.4 provides well-aligned ranges for the operating temperature for the accelerator magnet and the beam-screen.

Task 4.2: Study beam-induced vacuum effects (ALBA, CERN)
ALBA will model and compute the cryogenic beam vacuum system, both in static and in time-constant (so called "dynamic") modes based on the input provided by CERN (D-4.4). CERN will contribute to the implementation of the time-constant modelling, providing expertise and training. The model will include synchrotron radiation effects. In a second stage, ALBA, in close correlation with CERN, will evaluate options to implement cryo-photon absorbers and will propose a conceptual design for these absorbers, which are compatible with the accelerator magnet design and accelerator layout.

Task 4.3: Mitigate beam-induced vacuum effects (STFC, CERN)
STFC will study different coatings to mitigate beam-induced electron cloud and ion instabilities on flat samples and on beam-screen prototypes provided by CERN. Compatibility of these coatings with cryogenics temperatures has to be demonstrated, in particular sticking and flaking of coatings after several cool down and warming up cycles. CERN will review the testing conditions, results and analysis and will provide the beam-screen prototypes. This work flows into the engineering design (D-4.3)

Task 4.4: Study vacuum stability at cryogenic temperature (INFN, CERN)

INFN Frascati will determine vacuum stability and adsorption isotherms at different cryogenic beam screen operating temperature ranges (D-4.1). It will perform complementary studies on beam-induced stimulated desorption phenomena by photons, electrons and ions. These studies rely mainly on experimental samples and require beam-screen prototypes supplied by CERN.

Task 4.5: Develop conceptual design for cryogenic beam vacuum system (CERN, CIEMAT)
CIEMAT will closely collaborate with CERN on the mechanical design of the cryo-magnet beam screen, ensuring compatibility with fast magnetic transitions and cryogenic cooling concepts (D-4.3). CIEMAT and CERN will study and determine beam image current continuity and impedance issues on vacuum engineering and review the buckling safety factor accordingly. CERN will manufacture the beam-screen prototypes and qualify them in one of its magnet test stands at different beam screen temperatures. CIEMAT will assist CERN with instrumentation, measurements and qualification of the beam-screens.

Task 4.6: Measurements on cryogenic beam vacuum system prototype (KIT, INFN, CERN)
ANKA at KIT will be responsible for the “beam qualification” of the beam-screen prototype supplied by CERN (D-4.2). The goal is to determine synchrotron radiation heat loads and photo-electrons generation inside the beam-screen prototype. This beam-screen will be qualified with beam by installing the CERN COLDEX experiment in the synchrotron ring and expose the beam-screen prototype to significant levels of synchrotron radiation, comparable to the operation conditions at the hadron collider. CERN delivers to ANKA premises the COLDEX experiment together with all documents required to define and create the machine-COLDEX interfaces. ANKA will assist for the installation and integration of COLDEX carried out by CERN and INFN. INFN will commission the experiment and perform the measurements under CERN advice.

Participation per Partner

Partner number and short name	WP4 effort
1 - CERN	84.00
5 - KIT	15.00
7 - INFN	94.00
9 - ALBA	100.00
10 - CIEMAT	54.00
11 - STFC	96.00
Total	443.00

List of deliverables

Deliverable Number [14]	Deliverable Title	Lead beneficiary	Type [15]	Dissemination level [16]	Due Date (in months) [17]
D4.1	Analysis of vacuum stability at cryogenic temperature	9 - ALBA	Report	Public	22
D4.2	Measurements of vacuum chamber at light source	9 - ALBA	Report	Public	28
D4.3	Preliminary beam screen and beam pipe engineering design	9 - ALBA	Demonstrator	Public	29

List of deliverables

Deliverable Number [14]	Deliverable Title	Lead beneficiary	Type [15]	Dissemination level [16]	Due Date (in months) [17]
D4.4	Analysis of beam-induced vacuum effects	9 - ALBA	Report	Public	36

Description of deliverables

D4.1 : Analysis of vacuum stability at cryogenic temperature [22]

Description of simulation environment and assumed input parameters. Description of samples and existing prototypes used as baseline. Documentation of vacuum stability and adsorption isotherms at different beam screen operating temperature ranges from simulations and laboratory tests.

D4.2 : Measurements of vacuum chamber at light source [28]

Description of the test setup and the measurement conditions including any aspects that may have an impact on the quality of the raw data and analysis. Set of raw data, associated calibration data and relevant environment operation data. Preliminary summary of the analysis, discussion of the results and conclusions.

D4.3 : Preliminary beam screen and beam pipe engineering design [29]

Drawings of the beam screen and surrounding beam pipe mechanical design as produced for the measurements at the light source. Description of the materials and manufacturing processes used to produce the test element.

D4.4 : Analysis of beam-induced vacuum effects [36]

Description of the simulated effects and comparison to the analysis of measurement data taken at the light source. Discussion and conclusion of the effects and description of efficacy, risks and potential impacts of mitigation measures. Suggestion for implementation and future work.

Schedule of relevant Milestones

Milestone number [18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS5	WP4 group established and hiring complete	9 - ALBA	5	The working group covering WP4 (Cryogenic Beam Vacuum System Conception) has been formed, WP and task leaders have been identified and technical staff has been appointed.
MS13	Beam screen model heat load and photo-electrons density analysis	9 - ALBA	12	Develop a computer model of the beam screen and report on the analysis of heat load and photo electron densities under the assumed operation conditions. The analysis is made available on the project's document management system.
MS15	Measurement setup at light source operational	9 - ALBA	15	The setup for the measurements using the Coldex experiment at the ANKA lightsource

Schedule of relevant Milestones

Milestone number [18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
				has been completed. A report on the setup and the program on which measurements under which operation conditions to be performed is released on the project's document management system.
MS16	Proposal of coatings to mitigate electron-cloud effects	9 - ALBA	18	A report on suggested experimental surface treatments to mitigate electron-cloud effects is released on the project's document management system.
MS29	Preliminary cryogenic-beam-vacuum system design	9 - ALBA	45	Integrated report on the cryogenic-beam-vacuum system design, considering all studies and findings so far as input to the preparation of the Conceptual Design Report. Description of the key elements, quantities and data permitting to come to an overall cost estimate of the collider.
MS35	Report on recommended crygenic-beam-vacuum follow-up R&D	9 - ALBA	47	Gap analysis between findings of the study, towards a realization project: Portfolio of suggested R&D topics related to elements of the cryogenic beam vacuum system. In particular, identification of design elements remaining to be elaborated in greater detail or to be further optimised to come to a sustainable machine design.

Work package number [9]	WP5	**Lead beneficiary** [10]	1 - CERN
Work package title	High-field accelerator magnet design		
Start month	1	**End month**	48

Objectives

Field strengths in the order of 16 T as required for a high-energy hadron frontier collider are much beyond the highest field reached by a magnet with significant aperture available today. The target field strength requires novel concepts for conductor configurations (large current, stable, good winding properties), suitable coil shape (efficient, precise and with acceptable stress level) and compact structures, which are compatible with a four-fold increase in the electromagnetic force with respect to present state-of-the-art.
1) Explore design options for an accelerator dipole magnet in the range of 16 Tesla
2) Produce conceptual designs for the most promising options
3) Develop a calibrated cost model for system optimization studies
4) Develop a preferred option into a baseline design based on performance merits and cost estimates
5) Produce the engineering design of the selected baseline configuration, covering all electromagnetics, mechanical, thermal and operation aspects, including the manufacturing folder for a short model

Description of work and role of partners

WP5 - High-field accelerator magnet design [Months: 1-48]
CERN, TUT, CEA, INFN, UT, CIEMAT, KEK, UNIGE
Task 5.1: Work Package Coordination (CERN)
CERN coordinates the work of all other tasks of this work package to ensure consistency of the work according to the project plan and to coordinate the WP technical and scientific scope with the tasks carried out by the other WPs. Coordination duties include the organization of WP internal steering meetings, setting up of proper reviewing, reporting to project management and distribution of the information within the WP as well as to the other work packages. The task covers the organization the annual meeting sessions dedicated to the WP activity review and possible workshops or specialized working sessions, implying the attendance of invited participants from inside and outside the consortium.
In particular this WP requires coordination with other WPs on the following subjects:
• WP 2 (arc design and lattice integration): Refine and consolidate magnet field and quality values as well as permissible error margins. Provide feedback on feasible technical design to adjust overall collider baseline parameters and collider design
• WP 3 (experimental insertion region design): Understand constraints on the accelerator magnet design that may emerge from the physics performance goals
• WP 4 (cryogenic beam vacuum system conception): Iterate over magnet apertures, use and characteristics of superconducting materials to ensure proper modelling and design of the vacuum chamber prototype to be produced and measured at the light source

Task 5.2: Study accelerator dipole magnet design options (CEA, CERN, KEK)
CEA and CERN will review together different magnet design, coil and structure cross-sections (cos-theta coil configurations, block-coils, and canted solenoids) and mechanical concepts such as collars, bladder-and-keys based on analytical scaling (D-5.1). CERN reviews previous productions and CEA will summarize and qualify the magnet options. CEA and CERN will work jointly on the definition of key performance indicators such as operating margins, maximum stress, magnet dimension and mass. The results of the conceptual design will be combined with those from the cost model in task 5.3 to compare magnet configuration options and to choose a baseline magnet conceptual design for further analysis (tasks 5.4, 5.5 and 5.6) (D-5.2). The selection will be reviewed by a technical advisory committee (see task 5.1). KEK will explore potentials of alternative superconducting A15 materials (Nb3Al) and work on HTS cycled, low-loss magnets and HTS high field magnets (20 T option, basic R&D).

Task 5.3: Develop dipole magnet cost model (CERN, CEA, CIEMAT)
A well-calibrated cost model is an important ingredient to magnet design since it serves as a performance indicator (input for task 5.2) and determines the financial envelope of the collider design. A new analytical cost model for accelerator magnets based on materials and production features (D5.3) will complete existing models based on extrapolation of available production data. This work will be performed jointly by CEA, CERN and CIEMAT, heavily relying on data from the LHC magnet production (bending dipole at CERN and quadrupole at CEA). The model will be calibrated

against large-scale magnet productions and main cost contributors will be indicated to provide further guidelines for cost control.

Task 5.4: Develop electromagnetic design (INFN, CIEMAT, UT)
Optimise the coil and magnet configuration (D-5.1, D-5.2), to obtain good electromagnetic performance of the preferred magnet conceptual design in close interaction with the mechanical design (task 5.5) and quench protection (task 5.6). CIEMAT and INFN will work jointly on the electromagnetic design and optimization. CIEMAT will design the overall coil cross section and INFN will contribute analysis of field quality and transient effects. UT will provide an experimental database of DC and AC magnetization that serves as input to cross section optimisation of coil, ends, iron, non-linear and transient effects.

Task 5.5: Develop mechanical engineering design (CIEMAT, CEA, INFN, UT, UNIGE)
The forces in a 16 T accelerator dipole are unparalleled, calling for novel mechanical designs and good knowledge of the engineering margins. CIEMAT and CEA will jointly develop the coil and structure concepts. CIEMAT, CEA and INFN Genova will run 2D and 3D stress analysis of the components and assemblies with CEA focussing on the coil, CIEMAT and INFN looking at the overall structure and magnet assembly. UT will provide design limits for the stress- and strain behaviour of the cables, based on experimental data collected from relevant cable samples. UNIGE will provide design limits for the stress- and strain behaviour of superconducting strands and will provide results from experiments carried out with samples. This task is performed in close interaction with electromagnetic design (task 5.4) and quench protection (task 5.6). The work is direct input to D-2.1 and D-5.4.

Task 5.6: Devise quench protection concept (TUT, INFN)
Protection of a long 16 T accelerator dipole may be a limiting factor to magnet performance. It is important to review and assess detection and protection methods and to propose a robust concept. This work will be performed jointly by TUT and INFN L.A.S.A. Milano. Both partners will simulate various quench initiation and propagation cases based on the selected magnet design. TUT will cover the extrapolation to a string of magnets. This task requires close interaction with electromagnetic design (task 5.4) and mechanical design (task 5.5). This work is direct input to the CDR (D-1.7).

Task 5.7: Produce model manufacturing folder (CEA, CERN)
This task consolidates all design work into a manufacturing folder (D-5.4), consisting of manufacturing drawings for a dipole model sufficiently long (~ 1.5 m) to make relevant qualification measurements (performance, field quality, protection). The work will start with the approval of the electromagnetic design, mechanical design and quench protection analysis results after review by a technical advisory committee (see task 5.1). Specifications and drawings for the model magnet excluding tooling will be prepared and a calculation file with relevant design and analysis notes will be set up. CEA and CERN will work jointly on drawings using compatible CAD systems. CERN will create the repository for all calculation files and for all drawings. CEA will draft the assembly procedures.

Participation per Partner

Partner number and short name	WP5 effort
1 - CERN	80.00
2 - TUT	40.00
3 - CEA	36.00
7 - INFN	36.00
8 - UT	38.00
10 - CIEMAT	48.00
14 - KEK	12.00
16 - UNIGE	24.00
Total	314.00

List of deliverables

Deliverable Number [14]	Deliverable Title	Lead beneficiary	Type [15]	Dissemination level [16]	Due Date (in months) [17]
D5.1	Overview of magnet design options	1 - CERN	Report	Public	17
D5.2	Identification of preferred dipole design options and cost estimates	1 - CERN	Report	Public	26
D5.3	Cost model for dipole magnet	1 - CERN	Report	Public	39
D5.4	Manufacturing folder for reference design dipole short model	1 - CERN	Demonstrator	Public	46

Description of deliverables

D5.1 : Overview of magnet design options [17]

Description of relevant design options to be considered for further detailed studies. Summary of the relative merits, requirements, constraints and impacts of each of the options. Classification of the options according to merits and realization risks.

D5.2 : Identification of preferred dipole design options and cost estimates [26]

Detailed description of the preferred baseline design with its expected performances. Analysis of the individual merits and risks of the different, initial design options and justification for selection. The deliverable includes expected field levels, field errors and a cost estimate, which serve as input for the arc design consolidation. A summary of the technical expert advisory committee review is included. Description of requirements, constraints and impacts on environment, ancillary systems, arc, interaction region and cryogenic beam vacuum system.

D5.3 : Cost model for dipole magnet [39]

Description of the model, reference data used as basis, any assumptions, constants and parameters that can be used to tune the benefit versus cost ratio. Major cost drivers and potentials to control costs will be indicated. The model includes three baselines: optimistic, likely and conservative.

D5.4 : Manufacturing folder for reference design dipole short model [46]

Collection of all drawings, material and element specifications, assembly procedures. Calculation files indicating relevant design and analysis notes. Quantity and cost indications for materials and components required for production. Production quality requirements with tolerances.

Schedule of relevant Milestones

Milestone number [18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS6	WP5 group established and hiring complete	1 - CERN	5	The working group covering WP5 (High-field accelerator magnet design) has been formed, WP and task leaders have been identified and technical staff has been appointed.

Schedule of relevant Milestones

Milestone number [18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS8	Baseline specifications and assumptions for accelerator magnet	1 - CERN	10	Preliminary set of specifications for an accelerator main dipole magnet in terms of physical and performance characteristics as well as design constraints. Target goal ranges for the final design and priority indications for individual characteristics to be studied in greater detail. Report released on project document management system.
MS20	Specifications for conductors and proposed conductor configurations	1 - CERN	34	Report on the required physics and performance characteristics of the superconducting cables or their constituents, setting the performance targets for the industrial production requirements at large scale in view of the required accelerator dipole magnet. The specification is made available on the project's document management system.
MS32	High-field accelerator dipole conceptual design report	1 - CERN	46	Consolidated design work consisting of drawings, functional and performance specifications for a dipole model sufficiently long (~1.5 m) to make relevant qualification measurements on performance, field quality and protection in a followup project.
MS36	Report on recommended accelerator magnet follow-up R&D	1 - CERN	47	Gap analysis between findings of the study, towards a realization project: Portfolio of suggested R&D topics related to superconducting accelerator magnets. In addition to the main

Schedule of relevant Milestones

Milestone number [18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
				dipole magnet model, present a list of required accelerator magnets and indicate their baseline physical and performance characteristics along with an assessment of feasibility, realisation risk and relative cost.

1.3.4. WT4 List of milestones

Milestone number [18]	Milestone title	WP number [9]	Lead beneficiary	Due Date (in months) [17]	Means of verification
MS1	Web site available	WP1	1 - CERN	2	A web site with general information on the project, the management and governance structure, the work package descriptions and primary contact persons has been established. The site address has been released to the Consortium members.
MS2	EuroCirCol Kick-off Meeting	WP1	1 - CERN	3	The Kick-off meeting giving an overview of the project, establishing a working management and governance structure has taken place. Minutes of the executive management group have been approved and the work plan has been agreed.
MS3	WP2 group established and hiring complete	WP2	3 - CEA	5	The working group covering WP2 (Arc Lattice Design) has been formed, WP and task leaders have been identified and technical staff has been appointed.
MS4	WP3 group established and hiring complete	WP3	13 - UOXF	5	The working group covering WP3 (Experimental Insertion Region Design) has been formed, WP and task leaders have been identified and technical staff has been appointed.
MS5	WP4 group established and hiring complete	WP4	9 - ALBA	5	The working group covering WP4 (Cryogenic Beam Vacuum System Conception) has been formed, WP and task leaders have been identified and technical staff has been appointed.
MS6	WP5 group established and hiring complete	WP5	1 - CERN	5	The working group covering WP5 (High-field accelerator magnet design) has been formed, WP and task leaders have been identified and technical staff has been appointed.

Milestone number [18]	Milestone title	WP number [9]	Lead beneficiary	Due Date (in months) [17]	Means of verification
MS7	QA, publication and communication plan	WP1	1 - CERN	6	A plan describing the quality management processes and systems used in the scope of the study has been established and has been released on the document management system, which can be used by all Consortium members. The document includes a communication plan, which captures the communication and outreach strategy considering the identified target audiences.
MS8	Baseline specifications and assumptions for accelerator magnet	WP5	1 - CERN	10	Preliminary set of specifications for an accelerator main dipole magnet in terms of physical and performance characteristics as well as design constraints. Target goal ranges for the final design and priority indications for individual characteristics to be studied in greater detail. Report released on project document management system.
MS9	Preliminary arc optics and lattice files	WP2	3 - CEA	11	Produce preliminary arc optics in the form of lattice files to provide a baseline for dynamic aperture and magnet design studies. The files will be made available on the project's document management system.
MS10	Preliminary EIR optics and lattice files	WP3	13 - UOXF	11	Produce preliminary optics for the experimental insertion region in the form of lattice files to provide a baseline for studying radiation effects, machine detector interface and beam-beam interactions as well as an optimised design for a smooth transit from injection to collision optics. The lattice files will be made available on the project's document management system.

Milestone number [18]	Milestone title	WP number [9]	Lead beneficiary	Due Date (in months) [17]	Means of verification
MS11	Annual Report	WP1	1 - CERN	12	At the end of the first twelve months, each Beneficiary provides input for an interim activity report about the work performed in the tasks of all work packages, achievements, problems encountered and corrective actions taken as well as any major deviations from the original work description. The report includes an assessment of the project situation and any expected delays for the coming period.
MS12	Collider baseline parameters	WP1	1 - CERN	12	An annotated description of the hadron collider baseline layout and operation parameters, which serves as a baseline of work for design optimisation work.
MS13	Beam screen model heat load and photo-electrons density analysis	WP4	9 - ALBA	12	Develop a computer model of the beam screen and report on the analysis of heat load and photo electron densities under the assumed operation conditions. The analysis is made available on the project's document management system.
MS14	1st Annual Collaboration Meeting	WP1	1 - CERN	15	In the scope of the annual meeting report on progress, showstoppers and findings in the form of selective workshop presentations. Management and governance bodies of the project review the progress. The approved minutes of the bodies will be made available to the Consortium members and appropriate news coverage will be performed via the channels identified in the communication plan.
MS15	Measurement setup at light source operational	WP4	9 - ALBA	15	The setup for the measurements using the Coldex experiment at the ANKA lightsource has been completed. A report on the

Milestone number [18]	Milestone title	WP number [9]	Lead beneficiary	Due Date (in months) [17]	Means of verification
					setup and the program on which measurements under which operation conditions to be performed is released on the project's document management system.
MS16	Proposal of coatings to mitigate electron-cloud effects	WP4	9 - ALBA	18	A report on suggested experimental surface treatments to mitigate electron-cloud effects is released on the project's document management system.
MS17	Requirements and constraints of EIR design options on WP 2, WP 4, WP 5	WP3	13 - UOXF	23	Description of Experimental Insertion Region design options and their impacts onto arc design, cryogenic beam vacuum and magnet design in terms of relevance and potential realization risk and cost will be made available on the project's document management system.
MS18	2nd Annual Collaboration Meeting	WP1	1 - CERN	27	In the scope of the annual meeting report on progress, showstoppers and findings in the form of selective workshop presentations. Management and governance bodies of the project review the progress. The approved minutes of the bodies will be made available to the Consortium members and appropriate news coverage will be performed via the channels identified in the communication plan.
MS19	Outreach package	WP1	1 - CERN	28	Produce a set of outreach artefacts as identified in the communication plan. The package will be published at the next possible Consortium meeting and will be announced to the public via the identified communication channels.
MS20	Specifications for conductors and proposed	WP5	1 - CERN	34	Report on the required physics and performance characteristics of the

Milestone number [18]	Milestone title	WP number [9]	Lead beneficiary	Due Date (in months) [17]	Means of verification
	conductor configurations				superconducting cables or their constituents, setting the performance targets for the industrial production requirements at large scale in view of the required accelerator dipole magnet. The specification is made available on the project's document management system.
MS21	Arc key component functional design specifications for preliminary baseline	WP2	3 - CEA	35	Report on the list of key accelerator elements for the accelerator arc and their functional design properties, based on the existing preliminary arc design baseline. The report indicates also the foreseen quantities so to permit coming to an accelerator overall cost estimate.
MS22	Implementation and governance model	WP1	1 - CERN	37	Description of management and governance structures, which would be suitable for a construction phase of a large-scale, collider-complex based research infrastructure for high-energy particle physics.
MS23	EIR key component functional design specifications for preliminary baseline	WP3	13 - UOXF	38	Report on the list of key accelerator elements for the collider experimental insertion region and its functional design properties, based on the existing preliminary EIR design baseline. The report indicates also the foreseen quantities and constraints on the infrastructure (e.g. experiment cavern and machine-detector-interface elements) so to permit coming to a overall cost estimate of the collider.
MS24	3rd Annual Collaboration Meeting	WP1	1 - CERN	39	In the scope of the annual meeting report on progress, showstoppers and findings in the form of selective workshop presentations. Management and governance bodies

Milestone number [18]	Milestone title	WP number [9]	Lead beneficiary	Due Date (in months) [17]	Means of verification
					of the project review the progress. The approved minutes of the bodies will be made available to the Consortium members and appropriate news coverage will be performed via the channels identified in the communication plan.
MS25	Analysis of electron cloud effects and mitigation options	WP2	3 - CEA	40	Report on the results of the electron cloud effects studies using computer simulations, considering different geometric designs of beam pipe, different surface treatments and different beam configurations. Assessment of coming to a workable system for a preferred set of working points and resulting requirements and constraints on the overall collider design.
MS26	Report on design option for machine detector interface	WP3	13 - UOXF	40	Report on the machine-detector-interface requirements and constraints considering all studies carried out so far. Report on the impact of synchrotron radiation on detector and machine components in the interaction region and on the effects of debris onto magnets close to the detector. Report on radiation shielding and space constraints for experiments.
MS27	Consolidated arc design baseline	WP2	3 - CEA	41	Report on the collider arc design and its key elements considering the cumulative findings of all studies carried out so far, usable as input for the preparation of the Conceptual Design Report.
MS28	Consolidated EIR design baseline	WP3	13 - UOXF	41	Report on the collider Experimental Insertion Region design and its key elements considering the cumulative findings of

Milestone number [18]	Milestone title	WP number [9]	Lead beneficiary	Due Date (in months) [17]	Means of verification
					all studies carried out so far, usable as input for the preparation of the Conceptual Design Report.
MS29	Preliminary cryogenic-beam-vacuum system design	WP4	9 - ALBA	45	Integrated report on the cryogenic-beam-vacuum system design, considering all studies and findings so far as input to the preparation of the Conceptual Design Report. Description of the key elements, quantities and data permitting to come to an overall cost estimate of the collider.
MS30	Cost baseline	WP1	1 - CERN	46	Overall Product Breakdown Structure of the collider indicating quantities and costs with an indication of how to parameterize the cost overview in presence of evolving material, production and commodity resource costs and the constitution of a potential consortium for the realization of such a large-scale research infrastructure for high-energy particle physics.
MS31	Industry and outreach event	WP1	1 - CERN	46	Report on a dedicated event bringing together potential partners from industry and informing different identified target audiences about the advancement of the design for a next generation, collider complex based large-scale research infrastructure for high-energy particle physics.
MS32	High-field accelerator dipole conceptual design report	WP5	1 - CERN	46	Consolidated design work consisting of drawings, functional and performance specifications for a dipole model sufficiently long (~1.5 m) to make relevant qualification measurements on performance, field quality and protection in a followup project.

Milestone number [18]	Milestone title	WP number [9]	Lead beneficiary	Due Date (in months) [17]	Means of verification
MS33	Report on recommended accelerator follow-up R&D	WP2	3 - CEA	47	Gap analysis between findings of the study, towards a realization project: Portfolio of suggested R&D topics related to accelerator technologies and design elements remaining to be elaborated in greater detail or to be further optimised to come to a sustainable machine design.
MS34	Report on recommended collider follow-up R&D	WP3	13 - UOXF	47	Gap analysis between findings of the study, towards a realization project: Portfolio of suggested R&D topics related specifically to the interaction point, experimental area and machine detector interface design elements remaining to be elaborated in greater detail or to be further optimised to come to a sustainable machine design.
MS35	Report on recommended crygenic-beam-vacuum follow-up R&D	WP4	9 - ALBA	47	Gap analysis between findings of the study, towards a realization project: Portfolio of suggested R&D topics related to elements of the cryogenic beam vacuum system. In particular, identification of design elements remaining to be elaborated in greater detail or to be further optimised to come to a sustainable machine design.
MS36	Report on recommended accelerator magnet follow-up R&D	WP5	1 - CERN	47	Gap analysis between findings of the study, towards a realization project: Portfolio of suggested R&D topics related to superconducting accelerator magnets. In addition to the main dipole magnet model, present a list of required accelerator magnets and indicate their baseline physical and performance characteristics

Milestone number [18]	Milestone title	WP number [9]	Lead beneficiary	Due Date (in months) [17]	Means of verification
					along with an assessment of feasibility, realisation risk and relative cost.
MS37	Closing event	WP1	1 - CERN	48	Present the summarized achievements of the study and the planned dissemination actions in form of a scientific workshop with plenary and parallel track presentations. Give students the opportunity to show their work to the scientific audience. Present and discuss planned actions, which can follow this project as preparatory phase action towards a construction phase with targeted technical R&D activities.

1.3.5. WT5 Critical Implementation risks and mitigation actions

Risk number	Description of risk	WP Number	Proposed risk-mitigation measures
R1	Estimated human resources not adequate.	WP1, WP2, WP3, WP4, WP5	Care has been taken to balance WP coordination well between the participants of the consortium, to keep impacts limited and to be able to temporarily re-assign resources if needed. To mitigate any unforeseen priority changes in contingency cases, CERN will assign additional project associates and fellows as needed.
R2	Change of management team personnel during the project.	WP1, WP2, WP3, WP4, WP5	Coach and foster team work within coordination teams, in order to have competent project members within consortium available to step in if necessary. Monitoring and mitigation of this risk is part of CERN's coordination role.
R3	Unilateral withdrawal of key partner(s).	WP1, WP2, WP3, WP4, WP5	Other beneficiaries take over the responsibility of the task(s) and/or new beneficiaries are included in the project from the pool of FCC study partners. Monitoring and mitigation of this risk is part of CERN's coordination role.
R4	Detailed requirements from physics users are not available in time to finalize interaction region design.	WP2, WP3	Base assumptions on scaling the requirements and design constraints from existing LHC experiments and HiLumi LHC design targets. Indicate the assumptions in the conceptual design report.
R5	Time or limited understanding of beam effects does not permit finding satisfactory optimization of interaction region performance.	WP3	Freeze beam optics design according to understanding effects. Indicate in the conceptual design report the performance limitations and give estimates for further optimization potentials.

Risk number	Description of risk	WP Number	Proposed risk-mitigation measures
R6	Results from beam optics calculations and simulations are delayed.	WP2, WP3	Regular and early progress reviews via milestones help detecting unexpected complexities. Consequently, the number of design options will be reduced and the scope of the performance/cost optimizations will be adjusted to the available time.
R7	Required collimation system performance not reachable.	WP2, WP3	Adapt collider baseline parameters. Study alternative collimation methods such as hollow electron lens, crystal collimation, and moveable collimators.
R8	Results from accelerator magnet work package are incompatible with required collider performances.	WP2, WP3, WP5	Assess incompatibility impacts and adapt collider baseline parameters, e.g. increase circumference, lower nominal dipole field, lower ramp rates, lower maximum collision energy, lower beam current, lower luminosity.
R9	Vacuum chamber testing at light source incompatible with planned synchrotron operation.	WP4	Conclude agreement with alternative light-source with comparable operation parameters and the possibility to accommodate the measurement and test setup.
R10	Lack of equipment to set up measurements and tests of cryogenic vacuum beam-screen/beam-pipe system.	WP4	Foresee alternative equipment and understand the impacts on the measurement qualities. Delay the setup and measurement phase.
R11	Superconducting strand and cable data not available in time to confirm technical feasibility of magnet design.	WP5	Assess if measurements from models from comparable projects (EuCARD2, HiLumi LHC DS) can be used to obtain key performance indicators that can be scaled. Indicate likelihood to achieve field values and quality based on extrapolations from existing data and operational experience with

Risk number	Description of risk	WP Number	Proposed risk-mitigation measures
			LHC magnets based on Nb-Ti and give confidence margins.

1.3.6. WT6 Summary of project effort in person-months

	WP1	WP2	WP3	WP4	WP5	Total Person/Months per Participant
1 - CERN	128	90	42	84	80	424
2 - TUT	0	0	0	0	40	40
3 - CEA	0	108	0	0	36	144
4 - CNRS	0	64	0	0	0	64
5 - KIT	0	0	0	15	0	15
6 - TUDA	0	84	0	0	0	84
7 - INFN	0	0	30	94	36	160
8 - UT	0	0	0	0	38	38
9 - ALBA	0	0	0	100	0	100
10 - CIEMAT	0	0	0	54	48	102
11 - STFC	0	0	48	96	0	144
· UNIMAN	0	0	0	0	0	0
12 - UNILIV	22	0	0	0	0	22
13 - UOXF	0	0	88	0	0	88
14 - KEK	0	12	0	0	12	24
15 - EPFL	0	0	36	0	0	36
16 - UNIGE	0	0	0	0	24	24
Total Person/Months	150	358	244	443	314	1509

1.3.7. WT7 Tentative schedule of project reviews

Review number [19]	Tentative timing	Planned venue of review	Comments, if any
RV1	22	tbd	Mid-term Review

1.4. Ethics Requirements

Ethics Issue Category	Ethics Requirement Description
NON-EU COUNTRIES	- The applicant must confirm that the ethical standards and guidelines of Horizon2020 will be rigorously applied, regardless of the country in which the research is carried out.

1. Project number

The project number has been assigned by the Commission as the unique identifier for your project. It cannot be changed. The project number **should appear on each page of the grant agreement preparation documents (part A and part B)** to prevent errors during its handling.

2. Project acronym

Use the project acronym as given in the submitted proposal. It can generally not be changed. The same acronym **should appear on each page of the grant agreement preparation documents (part A and part B)** to prevent errors during its handling.

3. Project title

Use the title (preferably no longer than 200 characters) as indicated in the submitted proposal. Minor corrections are possible if agreed during the preparation of the grant agreement.

4. Starting date

Unless a specific (fixed) starting date is duly justified and agreed upon during the preparation of the Grant Agreement, the project will start on the first day of the month following the entry into force of the Grant Agreement (NB : entry into force = signature by the Commission). Please note that if a fixed starting date is used, you will be required to provide a written justification.

5. Duration

Insert the duration of the project in full months.

6. Call (part) identifier

The Call (part) identifier is the reference number given in the call or part of the call you were addressing, as indicated in the publication of the call in the Official Journal of the European Union. You have to use the identifier given by the Commission in the letter inviting to prepare the grant agreement.

7. Abstract

8. Project Entry Month

The month at which the participant joined the consortium, month 1 marking the start date of the project, and all other start dates being relative to this start date.

9. Work Package number

Work package number: WP1, WP2, WP3, ..., WPn

10. Lead beneficiary

This must be one of the beneficiaries in the grant (not a third party) - Number of the beneficiary leading the work in this work package

11. Person-months per work package

The total number of person-months allocated to each work package.

12. Start month

Relative start date for the work in the specific work packages, month 1 marking the start date of the project, and all other start dates being relative to this start date.

13. End month

Relative end date, month 1 marking the start date of the project, and all end dates being relative to this start date.

14. Deliverable number

Deliverable numbers: D1 - Dn

15. Type

Please indicate the type of the deliverable using one of the following codes:

R	Document, report
DEM	Demonstrator, pilot, prototype
DEC	Websites, patent fillings, videos, etc.
OTHER	

16. Dissemination level

Please indicate the dissemination level using one of the following codes:

PU Public

CO Confidential, only for members of the consortium (including the Commission Services)
CI Classified, as referred to in Commission Decision 2001/844/EC

17. Delivery date for Deliverable

Month in which the deliverables will be available, month 1 marking the start date of the project, and all delivery dates being relative to this start date.

18. Milestone number

Milestone number:MS1, MS2, ..., MSn

19. Review number

Review number: RV1, RV2, ..., RVn

20. Installation Number

Number progressively the installations of a same infrastructure. An installation is a part of an infrastructure that could be used independently from the rest.

21. Installation country

Code of the country where the installation is located or IO if the access provider (the beneficiary or linked third party) is an international organization, an ERIC or a similar legal entity.

22. Type of access

VA if virtual access,
TA-uc if trans-national access with access costs declared on the basis of unit cost,
TA-ac if trans-national access with access costs declared as actual costs, and
TA-cb if trans-national access with access costs declared as a combination of actual costs and costs on the basis of unit cost.

23. Access costs

Cost of the access provided under the project. For virtual access fill only the second column. For trans-national access fill one of the two columns or both according to the way access costs are declared. Trans-national access costs on the basis of unit cost will result from the unit cost by the quantity of access to be provided.