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FCCIS

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DELIVERABLE REPORT

DATA AND DISSEMINATION MANAGEMENT PLAN

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Abstract:

Documentation of the process, structures and tools to make data and publications openly accessible in this project applying the FAIR principles, “green” and “gold” open access publications.

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1. DATA MANAGEMENT PLAN

1.1. DATA SUMMARY

1.1.1. Purpose

Acquisition and collection of geological data and its associated data analysis contributes essentially to the project's technical risk management plan. Data analysis and its associated results serve (1) obtaining credible project construction cost and schedule estimates, (2) a world-wide community of engineers and entrepreneurs to propose credible and feasible re-use possibilities for excavated tunnel material and (3) increase the outreach of the scientific publications based on this data.
The data will be published on ZENODO to provide transparency and data clearance for potential re-use scenarios. For quality management purposes, all raw data, analysis results and ancillary data such as device calibrations and metadata will be stored at CERN in an EOS/CERNBOX repository with limited access. Also, some proprietary raw data and selected analysis results that are subject to publication constraints and time-based embargoes will be kept in this internal data repository. Our approach enables follow-up projects and further generations of researchers continuing to build upon existing data sets, to validate the results and to document the improvement of technologies and techniques in a verifiable manner. This approach will ensure a durable impact of the EC funding obtained by projects such as FCCIS and DEBI EU projects beyond the project period.

1.1.2. Relation to the objectives of the FCC project

The objective of the FCC project and the FCCIS EC co-funded project is to develop a feasible new particle-collider based research infrastructure that serve a world-wide community of scientists until the end of the 21st century. The collection, processing, maintenance, and publication of geological data will significantly help achieving this goal. In addition, establishing a durable library of raw data and analysis results can serve a large community of researchers, engineers, and entrepreneurs from different fields to:

- get a better understanding of the subsurface in the Franco-Genevois basin across France and Switzerland,
- support the development of economically viable re-use scenarios for excavated material, and
- serve as an example for a large-scale subsurface investigation project with a high green environmental impact.

1.1.3. Sample type & data format

Published data includes comprehensive results of rock samples that are listed among the following types:

- Cores: cylindrically-shaped rock samples, which can either be fully retrieved (full core) or split (half core). Core samples typically range from several cm to m in length, with typical diameters according to Oil and Gas company standard drilling procedures (e.g.,4 to 12 cm).
- Plugs: small cylindrically-shaped rock samples drilled from a core. Usually, these plugs range from 2 - 8 cm in length and between 1 and 3 cm in diameter.
- Cuttings: rock pieces as a result of the drilling process. Taken during drilling in a regular interval.
- Hand pieces: these rock samples are of irregular shape and usually taken from outcrops (surface geology). Note that previous sample types can be obtained from outcrop samples if they have a sufficient volume.

Depending on the type of sample different analyses are possible. The list above ranks qualitatively each sample type in decreasing order of the number of possible analyses. Please check the metadata of each analysis for further information on analysed samples. Results of these sample types are used to derive thorough correlations for the understanding of molasse material properties for tunnelling construction and engineering purposes:

- develop a 3D subsurface basin model,

- develop re-use scenarios for expected rock classification types during the excavation process, and
- create figures and plots in scientific publications, such that other researchers can compare results and full transparency and reproducibility is given.

Numeric data and plots are value tables in Open Document Spreadsheet format (.ods) for limited amounts of data with typed columns.
Larger data series are UTF-8 encoded, comma-separated-value files (RFC 4810) in textual format files with column value and data format description.
Images and raw measurement data files are provided by the measurement instruments and stored in subfolders with a unique name.
Document record and change track will be included (author contact information, status, version, change reason and date, description of contents, title, origin of data including a brief description of the measurement and/or experiment setup, sample ID, analysis scientist, sampler and processor) in a separate metadata file for each characterization action called METADATA.ODS.
Data files and images will be included in the open data sets and made available through a quality-managed data release procedure on ZENODO.
Proprietary raw and calibration data delivered by the measurement device may be published if access restrictions permit publication. These restrictions depend on the ownership of the raw data and the contractual conditions for making data openly accessible (e.g., through the EU H2020 funding instrument, data produced during a project for the purpose of the project must be made openly accessible by the project consortium).

Table 1 – Available templates for the different files

Template	Type	Version	Use Case
FCC-1611250930-JGU_SpreadsheetTemplate_V0100.ods	Open source spreadsheet	1.0	Limited amounts of data. Note that data columns have data types
FCC-1611250930-JGU_SpreadsheetTemplate_V0100.xlsx	MS Excel proprietary spreadsheet	1.0	Limited amounts of data. Note that data columns have data types
demodata.csv	Comma separated value file	1.0	Data series
demodata_description.csv	Comma separated value file	1.0	Description of the .csv data file contents in a .csv file
characterisation_metadata.ods	Spreadsheet	2.0	Metadata file for a set of characterised samples
metadata.ods	Spreadsheet	1.0	Metadata file for a data set
Creative Commons Attribution 4.0 International (CC BY 4.0) licence	Webpage	4.0	Contents of licence.txt file

1.1.4. Handling of existing data

Existing data from past and ongoing research and development projects within the scope of the FCC study serves as a basis for the data files and subsequent geomodelling.

1.1.5. Origin of data

The differentiation among data holder and data owner proves to be essential. The following list refers to data holders, who permit to analyse and process the data within the scope of the FCC project. These data sets might originate from:

- past and present subsurface investigations in the region carried out for different (non-FCC) purposes,
- past and present subsurface investigations contracted by CERN for different (non-FCC) purposes and
- subsurface investigations contracted by CERN for FCC purposes.

1.1.6. Expected size of data

The exact size of data is today unknown. Initial experience from different measurements permit revising this initial data management plan. The main data storage volume stems from raw seismic and borehole data, SEM, QEMSCAN and optical microscope images stored in high-resolution bitmap format. The following list should give a first estimation of potential storage volume, expecting maximum data quality:

- Active and passive seismic raw data: 1 - 15 TB.
- Borehole data: 1 - 500 GB.
- High-resolution images: 1 - 2 GB.
- Laboratory measurement results (e.g., CSV-files): 1 - 10.000 MB.

1.1.7. Data utility

1.1.7.1. Within the Consortium

The data sets will be shared within the consortium as the working baseline to:

- develop re-use scenarios for tunnel excavation material,
- create a 3D geological subsurface basin model of the project's perimeter, and
- produce scientific publications to validate results through repeated experiments at different locations.

1.1.7.2. Beyond the Consortium

The data can be used by independent researchers and engineers to understand the contents and conclusions of the scientific publications, which base their findings on the data. Furthermore, independent researchers can use the files to produce figures and publications, showing comparisons of their and the project's results. Scientists can use the data files to repeat the experiments and measurements to verify and validate the project's research. The data sets can be used by a world-wide set of researchers, engineers, and entrepreneurs to develop credible re-use scenarios for tunnel excavation material. The data sets can be used by public entities to increase their understanding about the geology in the Franco-Genevois basin. The data sets may be used by scientific writers and the press to produce high-quality infographics, demonstrating the scientific impact and potential of the FCC project.

1.2. FAIR DATA

1.2.1. Making Data Findable, Including Provisions for Metadata

1.2.1.1. Discoverability

The ZENODO.ORG platform will be used to make the data openly accessible and discoverable. Links to the data will be made available on the FCC Twiki collaborative web site together with metadata describing the data sets once they are released on ZENODO. A link on the FCC public website fcc.cern is provided. The data will be indexed using the EU Open Data Portal. Since the open data supports the quality and credibility of the open publications, all data are discoverable through the scientific publications. Each scientific publication will include Digital Object Identifiers (DOI) that direct to the associated open data sets.

1.2.1.2. Identification

Each data set is labelled by a DOI as a unique and persistent identifier. Data sets will be referenced in scientific publications and if the open data platform permits, scientific papers based on the data will be linked on the open data platform. The DOI is reserved when a ZENODO entry is created before any data are uploaded to the platform. At this point, the data set is not published, and its visibility is classified ad "Closed Access".

1.2.1.3. Metadata

The data sets follow the EU Open Data Portal Metadata definitions. From the comprehensive set of fields, a minimum set will be provided. The Dublin Core Metadata Initiative will be followed as much as possible. For all characterisations, at least the following metadata will be provided via the ZENODO upload form and the individual metadata files in the data folders:

Table 2: metadata provided via the ZENODO upload form and individual metadata files in the data folders

Metadata element	Description
Project identifier	Points to a subfolder with the same name, holding the data
Title	Meaningful name of the sample characterisation
Alternative title	Other identifier in concise format
Description	Brief description of the data set
Keywords	List of keywords according to the library of congress terms
Identifier	Digital Object Identifier (DOI) reserves for this data set
URI	Uniform Resource Identifier linking to the place where the data are stored. Usually the path of the folder in the file system
Dataset type	Type of the bore log or material sample (e.g. cube, surface, loose rock)
Documentation	Detailed description of the dataset content
Format	File type of the data set, usually a compressed ZIP archive
Issue date	Date of the first issue
Modification date	Last date the data sample set was modified
Publisher	Usually the FCC collaboration
Contact point	Name of the organisation and service at the organisation who is in charge of that data sample
Contact full address	Address of the contact and organisation in charge of that data sample
Contact e-mail	E-mail address of the contact person
Contact name	First name and last name of the person who is in charge of the data sample
Contact Web page	A web page
Version number	Major and minor version number of the published data set. A minor version number 0 indicates a released version
Version description	Incremental change record
Licence	Link to licence text
Owner	Name of the person who must authorize the release of specifically marked information items
Status	One of IN WORK (minor version not equal 0), RELEASED (minor version number is 0), INVALID
Materials	A list of individual materials present in the sample as far as known
Dimensions	Sample dimensions (mass, diameter, length, width)
Origin	Geographical coordinates of the sample's origin
Source	Who provided the sample
History	A record of actions at different locations that indicate, how the sample was obtained, used and characterised
Additional information	Free text with additional comments

The folder *data* of the CERNBOX file share contains a file called *CATALOG.ODS* that provides the most important metadata, notably the project identifier of the sample characterisation, which directs to the folder in which the open data is stored. The GEO database catalogue is also available on the geo database Twiki page.

The following data description elements are collected for the catalogue:

Table 3: data description elements collected for the GEO database catalogue

Data element	Description
Data set identifier	Identifier in format LLL-YYMMDD
URI	Uniform Resource Identifier linking to the place where the data are stored. Usually, the path of the folder in the file system. A CERNbox link may either be public or accessible only to members of the e-group if the data are not yet published
OID	Digital Object Identifier filled if reserved in ZENODO
Title	Concise name of the data set
Version	Current version of the data set
Status	Release status of the data set (*RELEASED, IN WORK, INVALID)*
Organisation	Short name of the organisation that created and manages this data set
Contact name	Name and e-mail (hyperlink) of the person who serves as contact point for this data set
Type	Type of the data set, e.g. a bore log or material sample (e.g. cube, surface, loose rock)
Source	Where the materials for this data set have been obtained from (e.g. contracted extraction, other project, literature)
Location N/E	Geographical coordinates where the materials that relate to this data set have been taken from
Description	Brief description of the data set
Last update	Date when this record has been updated

**NOTE: * It is understood that these fields are duplicates of those fields, which are also stored at a lower measurement folder level. The repetition at higher level serves a simple, easy-to-use catalogue in the project.*

Each data set is stored in a separate sub-folder. Each data set sub-folder has either a) folders for different samples that have been characterised or b) immediately folders for the characterisation data of the entire data set.
If a data set folder has sample sub-folders, each sample sub-folder contains a *METADATA.ODS* file that describes the specific data set according to the metadata elements indicated above.

1.2.2. Versioning

A dataset has a major (*MM)* and a minor (*mm)* version number, separated by a dot (*MM.mm)* .
***Note**: The ZENODO recommended patch number is not used. It should always be ".0".*

If the minor version number is *0*, the data set is released. Any minor version number different from zero indicates a data set that is in work. At each release, the major version number is incremented by one. For each change in an "in work" version, the minor version number is incremented by one. The first "in work" version starts with a major version number equal to 0.

Examples:

V 0.0 - the first draft version,
V 0.1 - a second draft version,
V 1.0 - the first released version,
V 1.1 - an update to Version 1.0, not yet released,

V 2.0 - another released version. Version 1.0 is now invalid.

Versions comply with the data set status and can either be:

1. *IN WORK* (not released),
2. *RELEASED*, or
3. *INVALID* (must no longer be used as reference).

***Note**: INVALID and IN WORK version must not be published and be referenced in publications.*

1.2.3. Naming convention

1.2.3.1. Data set identification

A data set comprises multiple samples and sample analysis records.

The project identifier for a data set uses the following convention: *LLL-YYMMDD*

where *LLL* is the three-letter abbreviation of the **organisation at which the data set is created**, e.g., MUL for Montanuniversität Leoben.

YY stands for the last two digits of the current year, e.g., *18* for *2018*.

MM stands for the two digits of the current month, e.g., *04* for *April*.

DD stands for the two digits of the current day of month, e.g., 17 for the seventeenth day.

A complete example for a project identifier is TUW-180317.

The three letter abbreviations of an exemplary number of organisations, which typically carry out material characterizations are shown in the table below. This document will be regularly updated. The three-letter abbreviations do not coincide with the typical organisation abbreviations used to identify an organization in EC projects. They merely serve coming to unique project identifiers for sample characterizations.

Abbreviation	Organisation
MUL	Montanuniversität Leoben
UNIGE	Université de Genève
ETH	Eidgenössische Technische Hochschule

1.2.3.2. Sample and analysis identification

Files that relate to samples and data from different analysis processes are placed in subfolders of the data set according to this structure:

LLL-YYMMDD is the name of the folder for a data set that contains multiple sample characterisations.

LLL-TTMMDD-{running number}-{type} is the name of a sub-folder in LLL-YYMMDD that holds the analysis data of a specific sample or characterisation.

{type} can be

1. either sample to indicate that the folder contains data of a single sample that has been analysed with one or several methods, or
2. {characterisation method abbreviation} to indicate that this folder holds data for a specific characterisation method.

Table 4: sample analyses registered as of April 2021

Characterisation method abbreviation	Characterisation method name	Description
QEMSCAN	Automated mineralogy and Petrography apparatus	Modal mineralogy, lithology, grain density
FTIR	Fourier Transform Infrared Spectroscopy	Mineral components in mixtures to distinguish among different types of clay minerals, characterization of both di- and trioctahedral clay minerals, amounts of kaolinite and Al/Mg/Fe types, organic material
OMI-T	Optical Microscopy in transmitted light	Optical analysis, 2.5x to 50x magnification
OMI-R	Optical Microscopy in reflected light	Optical analysis, 2.5x to 50x magnification
pXRF	Portable X-Ray Fluorescence	Elemental composition in portable format
XRD-P	X-Ray diffraction on powder sample	Identification of mineral phases on randomly oriented sample
XRD-S	X-Ray diffraction on textured sample	Identification of clay minerals on oriented sample
XRD-EG	X-Ray diffraction on ethylenglycole-treated sample	Identification of swelling clays
ICP-MS	Inductively Coupled Plasma	Elemental composition using mass spectroscopy
ICP-OES	Inductively Coupled Plasma	Ultra-trace elemental composition using an optical emission spectrometer to identify leaching characteristics
CUV	Cuvette Tests	Identification of chemical pollutants and leaching characteristics complementary to ICP-OES
UCS	Uniaxial Compressive Strength	Uniaxial Compressive Strength
LCPC	Laboratoire Central des Ponts et Chaussées	LAB and LAC values for abrasivity and breakability
CER	Cerchar abrasivity	Abrasivity behavior
VPS	Sonic P- and S-wave velocity	Sonic velocities in longitudinal and transversal direction
BRZ	Brazilian tensile strength	Tensile strength behavior
PL	Point Load	Point load index, rock strength parameter
PORO_gas	Porosity	Total & effective porosity measurements using gas adsorption
PERM_gas	Permeability	Helium / Nitrogen permeability measurements using gas adsorption
CEC	Total Cation Exchange Capacity	Total identification of solved ions in pore water and pores
CEC-ICP	Effective Cation Exchange Capacity	Effective identification of solved ions in pore water and pores using ICP optical emission spectrometer

Enslin-Neff	Free Water Uptake Capacity	Water suction of samples under free swelling conditions
Keeling	Vapour Water Adsorption	Water adsorption under 75% NaCl atmosphere identifying specific (inner crystalline) surface
BET	Brunauer-Emmett-Teller	Determination of specific (outer) surface
TC/TOC	Total carbon / Total Inorganic Carbon Content	Measurement of total organic and total inorganic carbon content, as well as derivation of total organic carbon content via difference-method
MIP	Mercury Intrusion Porosimetry	Identification of pore size, pore size distribution and porosity by high-pressure mercury intrusion

1.2.3.3. Filename and folder naming

The filename of a sample or data set contains a clear, concise and short name (e.g., borehole name or outcrop name) that describes the location, followed by the representative feature (e.g., depth) and analysis method in the format of e.g., fullwellname_depth_analysismethod. The "analysismethod" depicts the common abbreviation of an analysis in a maximum of four letters, e.g., X-Ray Fluorescence (XRF) or PORO (porosity). Words are in lowercase and separated by underscores ("=_="). CamlCase is discouraged. In compliance with these regulations, an example file name would be: geo02_148_xrf. This sample originates from the well GEO02 (full well name) at a depth of 148m analysed by a X-Ray Fluorescence device, i.e. elemental (geochemical) composition analysis. Further filename extensions are encouraged to ease the understanding of the folder contents such as additional data sets within the same file (several measurements) or in case of measurements on different sample types (e.g., halfcore or cuttings).
All data sets are stored in the folder `data` of the `fccgeo` EOS/CERNBOX project.

1.2.3.4. Folder structure

Each top level data set folder contains at least the following files:

- `LICENCE.TXT` - Text of the Creative Commons CC BY 4.0 licence. Additional note about the data creator if needed including specific clauses on a case-by-case basis,
- `METADATA.ODS` - the metadata if the data set including the change track record.

Each data set folder contains sub-folders. These folders hold information about the entire data set from which the samples are taken and sub-folders for individual sample analysis tasks.
Collaboration members shall report needs for further characterisation methods in a timely fashion so that the `template` folder at top level can include further examples. The file and folder's naming convention will evolve according to project requirements and growing experience.
One sub-folder needs to be created in a data set folder for each sample that is analysed with multiple techniques or for each analysis technique as indicated above.
Each sample specific sub-folder holds a `CharacterisationMetadata.ods` file that describes the sample and the analysis carried out on that sample. Depending on the numbers of samples taken from the original material and the different types of characterisation performed, two options exist:

1. Either there exists one sub-folder in the data set for each sample taken from the material lot (preferred) or
2. there exists one sub-folder for each characterisation. Both is valid.

The sub-folders are named by extending the data set naming conventions with a dash (-) followed by a sequence number, another dash (-) and the word `sample` or the abbreviation of the characterisation method.
If a single sample is analysed with different analysis methods, the sample folder contains one sub-folder per analysis method that has the name of the analysis method (e.g., `SEM, TEM)`.
In each sample or characterisation folder, the following sub-folders in each sample/characterisation folder exists:

- `img` for images,
- `raw` for any raw data files that devices deliver during the analysis, including calibration data files,
- `results` for the derived analysis data and results of the characterisation,
- `doc` for any additional documentation such as manuals, process descriptions, sample preparation instructions and
- `misc` for any additional information files.

The following image shows two possible folder structures. The structure example and the files can be found in the `template` folder (Annex 1).

Another example is re-produced in tabular form:

Path name	Description
/eos/project/f/fccgeo/data/CRN-200301	Folder for a bulk of materials taken at CERN
/eos/project/f/fccgeo/data/CRN-200301/Metadata.ods	The metadata file that describes that material taken and the list of analysis performed
/eos/project/f/fccgeo/data/CRN-200301/img	Sub-folder that holds images that relate to the entire data set (e.g. of the borelog)
/eos/project/f/fccgeo/data/CRN-200301/raw	Sub-folder that holds the raw data files (e.g. the scanned borelog)
/eos/project/f/fccgeo/data/CRN-200301/results	Sub-folder that holds the analysis results that relate to the entire data set
/eos/project/f/fccgeo/data/CRN-200301/doc	Sub-folder that holds the additional documentation that permits better understanding the data set
/eos/project/f/fccgeo/data/CRN-200301/misc	Sub-folder that holds miscellaneous additional information files
/eos/project/f/fccgeo/data/CRN-200301/CRN-200301-1-sample	Sub-folder for a qualitative analysis of a part of the material extracted
/eos/project/f/fccgeo/data/CRN-200301/CRN-200301-1-sample/CharacerisationMetadata.ods	Metadata file that describes the subset of the materials and the characterisation
/eos/project/f/fccgeo/data/CRN-200301/CRN-200301-1-sample/img	Sub-folder with images of the sample
/eos/project/f/fccgeo/data/CRN-200301/CRN-200301-1-sample/results	Sub-folder with results of the sample analysis
/eos/project/f/fccgeo/data/CRN-200301/CRN-200301-1-sample/SEM	Sub-folder with data relating to the SEM analysis method of that specific sample
/eos/project/f/fccgeo/data/CRN-200301/CRN-200301-1-sample/SEM/img	Sub-folder with images from the SEM analysis of that specific sample
/eos/project/f/fccgeo/data/CRN-200301/CRN-200301-1-sample/SEM/raw	Sub-folder with the SEM device raw data
/eos/project/f/fccgeo/data/CRN-200301/CRN-200301-1-sample/SEM/doc	Sub-folder with the SEM device description, sample preparation information and process description
/eos/project/f/fccgeo/data/CRN-200301/CRN-200301-2-SEM	Sub-folder for a spectroscopy analysis of another part of the material extracted
/eos/project/f/fccgeo/data/CRN-200301/CRN-200301-2-SEM/CharacerisationMetadata.ods	Metadata file that describes the subset of the materials and the characterisation

/eos/project/f/fccgeo/data/CRN-200301/CRN-200301-2-SEM/img	Sub-folder that holds images taken during the analysis
/eos/project/f/fccgeo/data/CRN-200301/CRN-200301-2-SEM/raw	Sub-folder that holds the raw data files obtained during the analysis
/eos/project/f/fccgeo/data/CRN-200301/CRN-200301-2-SEM/results	Sub-folder that holds the analysis results and result data files obtained after the analysis
/eos/project/f/fccgeo/data/CRN-200301/CRN-200301-2-SEM/doc	Sub-folder that holds the additional documentation that permits better understanding the results (e.g. device manuals)
/eos/project/f/fccgeo/data/CRN-200301/CRN-200301-2-SEM/misc	Sub-folder that holds miscellaneous additional information files

1.3. DATA FORMAT

A set of sample characterisation data is uploaded as a compressed archive file in .ZIP format to ZENODO together with the following separate files:

- `licence.txt` (text of the CC BY 4.0 licence in UTF 8 format)
- `METADATA.ODS` (spreadsheet describing the entire data set)
- `./{subfolders of selected sample characterisations to be published}` (organisation of the sub-folders can either be by sample or by characterisation method)

Note: Each subfolder corresponding to a specific measurement action will contain only those files for which the collaboration members agree to publish openly. Usually, these comprise spreadsheets in open format (.ODS) and comma separated value files (.CSV) as well as high resolution images (.PNG, .TIFF, .JPEG), vector plots (.EPS, .PDF) and summary documents (.PDF).

1.4. KEYWORDS

Each dataset will at least be tagged with the following keywords:

1. FCC,
2. FCCIS (if the data set is part of the FCCIS EC co-funded project),
3. H2020 (if the data set was created as part of an EC co-funded project).

In addition, appropriate keywords from the Library of Congress Subject Headings classification will be added (see http://id.loc.gov/authorities/subjects.html):
The keywords need at least to include:

1. Discipline,
2. sample type,
3. type of materials,
4. properties or methods used for characterization.

A selected list of entries from the following keyword terms and the link to the keyword term need to be entered in the two distinct fields foreseen in the ZENODO upload webform:

Term	Identifier link
Disciplines	URI
Geology	http://id.loc.gov/authorities/subjects/sh85054037
Engineering geology	http://id.loc.gov/authorities/subjects/sh85043221
Materials science	http://id.loc.gov/authorities/subjects/sh85082094
Sample type	URI
Prospecting geophysical methods	http://id.loc.gov/authorities/subjects/sh85107597
Electric prospecting	http://id.loc.gov/authorities/subjects/sh85041941
Magnetic prospecting	http://id.loc.gov/authorities/subjects/sh85079731
Seismic prospecting	http://id.loc.gov/authorities/subjects/sh85119624
Geophysical well logging	http://id.loc.gov/authorities/subjects/sh85054183
Materials	URI
Molasse	http://id.loc.gov/authorities/subjects/sh85086543
Limestone	http://id.loc.gov/authorities/subjects/sh85077017
Moraines	http://id.loc.gov/authorities/subjects/sh85087196
Gravel	http://id.loc.gov/authorities/subjects/sh85056544
Properties	URI
Abrasion resistance	http://id.loc.gov/authorities/subjects/sh2008000012
Soil porosity	http://id.loc.gov/authorities/subjects/sh86005323
Soil permeability	http://id.loc.gov/authorities/subjects/sh85124367
Characterisation	URI
Physical measurements	http://id.loc.gov/authorities/subjects/sh85101564
Microscopy	http://id.loc.gov/authorities/subjects/sh92003369
Transmission electron microscopy	http://id.loc.gov/authorities/subjects/sh93001918
Scanning electronic microscopy	http://id.loc.gov/authorities/subjects/sh91002757
Compression testing	http://id.loc.gov/authorities/subjects/sh85082069

1.5. METADATA STANDARDS

The Dublin Core Metadata Initiative will be followed (http://dublincore.org) as much as reasonably applicable. Metadata examples concerning the sample measurement campaigns such as http://icatproject-contrib.github.io/CSMD/csmd-4.0.html and an existing sample database at CERN have been considered. However, to our best knowledge, no domain-specific metadata standard for those sample characteristics identification campaigns specified in the project exist. Therefore, a column-oriented data format with an explanation of the columns will be created in the scope of this project.

1.6. TEMPLATES

Template folder and files can be found in the folder `fccgeo/templates`.
The entire folder `fccgeo/templates/CRN-200728` is an empty example that can be copied into the folder `/fccgeo/data` to be renamed using the naming convention for the data set `LLL-YYMMDD` to create a new data set. It contains the exemplary required files and exemplary characterisation subfolders.

1.7. STORAGE ADMINISTRATION AND ACCESS PERMISSIONS

1.7.1. Data store location

Data from subsurface samples are stored on a dedicated cernbox/eos data repository. This repository can be accessed either via a website or via a cernbox client application.
The path to the data share reachable directly on `lxplus` is `/eos/project/f/fccgeo`
The data share is owned by the service account `fccgeo` (`fcc.geo@cern.ch`).
If you have access to the repository through membership of one of the e-egroups, you can directly access the share using a web browser:
https://cernbox.cern.ch/index.php/apps/files?dir=/__myprojects/fccgeo

1.7.2. Access permissions

Access to the data store is managed via three e-groups following the cernbox access documentation:
`cernbox-project-fccgeo-admins` members have full access to the project in the cernbox website and can add readers and writers to the respective egroups.
`cernbox-project-fccgeo-writers` members can read, write, delete in the project space. They have only access to the cernbox share via the pathname.
`cernbox-project-fccgeo-readers` members can only read the files in the project space, They have only access to the cernbox share via the pathname.

1.8. MAKING DATA OPENLY ACCESSIBLE

Data from characterization campaigns will be made openly available only after approval of all persons who were involved in that characterization. Publication on ZENODO follows a quality management Data Release Procedure.
Note: Persons publishing data on the ZENODO platform need to sign up with an account at that platform at https://zenodo.org/signup/.

1.9. INCREASE DATA RE-USE THROUGH CLARIFYING LICENSES

1.9.1. Licence

Openly accessible data will be licensed under **Creative Commons CC BY 4.0** (see https://creativecommons.org/licenses/by/4.0/).
Users are free to:

- **Share** — copy and redistribute the material in any medium or format,
- **Adapt** — remix, transform, and build upon the material.

for any purpose, also commercially.

The licensor cannot revoke these freedoms as long as you follow the license terms.
Under the following terms:
Attribution — You must give appropriate credit, provide a link to the license, and indicate if changes were made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.
No additional restrictions — You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits.
Notices: You do not have to comply with the license for elements of the material in the public domain or where your use is permitted by an applicable exception or limitation documented by CC BY 4.0. No warranties are given. The license may not give you all of the permissions necessary for your intended use. For example, other rights such as publicity, privacy, or moral rights may limit how you use the material.

1.9.2. Timing

Data will at latest be made available with the publication of an accompanying scientific publication that references the data sets. All data will at latest be available with the project end, even those data sets, which are not referenced in scientific publications. Data publication may occur after the **six months EC H2020 permitted** embargo period has elapsed. Data published may contain a subset of those data that are not subject to access restrictions or if publication would violate other existing license restrictions.

1.9.3. Re-use

Published data can be used by other scientists. Original data revealing particular sample preparation or analysis techniques that are subject to access restrictions will only be usable by researchers upon explicit request and approval of the characterisation campaign manager and the data owner.

1.9.4. Validity

The data will remain usable until the repository withdraws the data or leaves business.

1.10. QUALITY ASSURANCE

Data sets, metadata and measurement setup and procedure description will be reviewed by at least one peer from the related scientific domain prior to engaging the release procedure. The author and the reviewer are named in the metadata.
Data sets, metadata and measurement setup and procedure description will be marked as `RELEASED` after approval of the measurement campaign manager (e.g., project supervisor) and one additional reviewer. Each approver is named in the metadata.
Review and release include a validation of the measured sample, the measurement setup, conditions, procedure, and equipment as well as sanity checks against similar studies and control of systematic errors by a related person from the scientific field. The person, who conducted the measurements cannot be simultaneously approve the measured data set. For scientific research (e.g., doctoral thesis), the associated academic supervisor must approve the data.
In case of data quality uncertainties after release, a new version `IN WORK` is created and the released data set version is marked `INVALID`.
The description of analysis/characterisation setup (materials and method) are annotated with product references.
The measurement conditions are described.
The measurement location, date and time (periods) are noted.
Any potential and known adverse effects (environmental influences, influences of the measurement equipment) must be described in the metadata.

1.11. ALLOCATION OF RESOURCES

1.11.1. Cost estimate

A person at CERN reachable through the service account `fcc.geo@cern.ch` keeps the measurement data sets and perform the publication in the open data repository. The estimated effort to manage a data set is 40 hours, 10 data sets per year, i.e., 400 hours or 10 weeks per year over the entire project period.

This resource is covered by the project management funds and CERN matching resources.
Note: the project coordination office will track the actual efforts and regularly update this estimation.
Each researcher in the project is responsible to create the data sets using the adopted open data format, providing the metadata files, describing the measurement setup, anonymising, or selecting the data for publication, reviewing the data sets and performing the release process using the CERN provided storage infrastructure (EOS, CERNbox) and the ZENODO platform. The estimated effort is another 40 hours per data set, 10 data sets per year, i.e., 10 weeks per year over the entire project period.
This resource is covered by the organisations that carry out the measurement campaigns.
Note: The participating institutes are strongly encouraged to track the time they are spending to prepare the data sets and to publish them and to report their actual estimates to the Coordinator.

1.11.2. Data management responsibilities

This data management plan is maintained by the FCC office at CERN (`fcc.office@cern.ch`).
All project members at the co-operating organisations commit to cooperate on the establishment of this DMP and to deliver the required information such that the associated deliverables and milestones can be produced in due time with the required quality levels:
Data storage and backup responsibilities are covered by the data repository provider (CERN).
The CERN project repository is managed by the CERN IT department.
Service account holder `fcc.geo@cern.ch` manages the data store.
The FCC secretariat and office (`fcc.office@cern.ch`) provides support for the upload to the CERNBOX/EOS data storage system and perform a formal (file integrity, naming, metadata completeness) check.
Long-term data preservation will be ensured by CERN at no additional cost.

1.12. DATA SECURITY

All data delivered to the CERN project repository EOS/CERNBOX storage system is backed up by CERN's central IT services. In addition, a copy of released data will be kept on the ZENODO platform. Both services are intended for long-term storage of scientific research data. Upon unintentional loss of data (misuse of the collaborative workspace, accidental removal), the fcc.geo@cern.ch service account holder needs to be contacted via email. The person will interact with CERN's IT services to restore the latest known copy. No additional costs occur for storage, backup and restore activities.
Non-public data sets can be provided by the project members using HTTPS transfer protocol after authentication by sharing a CERNbox link and asking the service account holder in a reasonable secure fashion counteracting data manipulation.
Sensitive data, i.e., non-anonymized data sets can only be accessed by the author, the measurement campaign management, and the project IT managers.
Access to sensitive data may be granted through a request to the network coordinator (CERN) with a justification of request. Access will be granted on a case-by-case basis in agreement with the measurement campaign manager and, if samples, analysis, and products from industrial partners are involved, in agreement with the sample owners. The data will be communicated in electronic format from the network coordinator to the data requestor in digitally signed and encrypted form. An additional IP access process, such as the establishment of a Non-Disclosure Form may apply.
Every collaboration member must inform the network coordinator without delay if a person affiliated (associated or employed) with the institute and who has access to the project data, leaves the institute. In this case, the network coordinator will revoke as soon as technically possible and resources permitting (working hours) the access of the person to the data.
Note: E-mail is not considered a secure communication channel for data and metadata files. Data can be modified, and it is unclear what fields have been modified with respect to the original data source. Therefore, only a link to the authentic data source shall be considered reliable information.

1.13. ETHICAL ASPECTS

Sensitive information will be kept secure. Access to non-anonymized data is managed by the network coordinator in close cooperation with the organisation, who provides the data set. Non-anonymized data will only be communicated in encrypted fashion and digitally signed.

2. DISSEMINATION PLAN

2.1. DISSEMINATION RESULTS

The plan for maximising the impact is governed by strategic stakeholder management (Figure 1). Its role is to integrate the demands of stakeholders in the decision-making process, according to their powers and interests. This includes raising awareness, sharing of information, joint activities and transparency in the decision-making process. The experimental physics users and the consortium members designing the RI are the key stakeholders. Five stakeholder classes have been identified around this core and these are considered in the dissemination, communication, and exploitation activities. Ultimately, the stakeholder management aims to enhance the sustainability of the RI design and preparation phases through continuous reflection and integration of constructive criticism. Based on this approach, the plan for dissemination and exploitation unfolds in three directions:

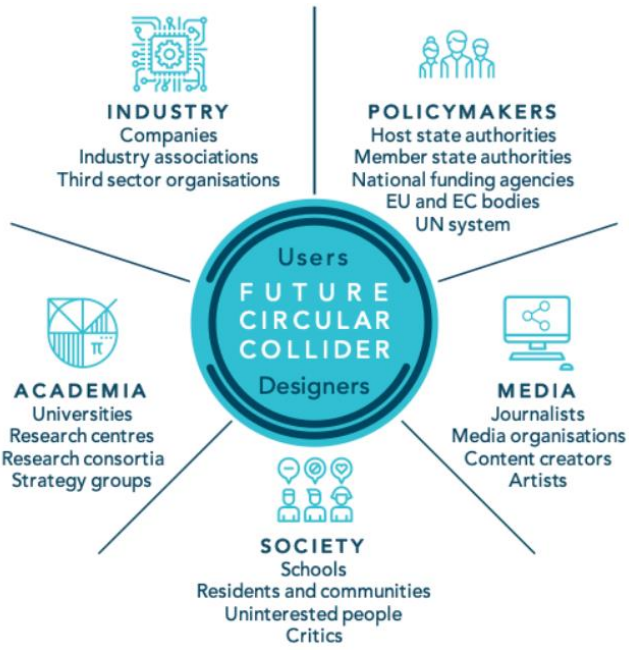


Figure 1 - Stakeholder management model for the project

1) build awareness among stakeholders for the project objectives and expected results,
2) build up capacity by **actively engaging key actors** in the development process and give them a deeper understanding of the project's objectives and advancement,
3) **maximise the exploitation of the results beyond the project duration**.

2.2. PLAN FOR DISSEMINATION OF RESULTS:

2.2.1. Dissemination and exploitation goals, target groups and disclosure pathways

Table 5 shows the plan for the public disclosure of the tangible outputs that will generate impact. The plan is based on the **goals for dissemination that derive from the project objectives** (Annex 2Annex 1), the **target groups** and **general dissemination actions**. **Table 6** summarises**, how, by whom and for which purposes the results will be used**. **Table 7 to Table 15** give an overview of the planned documents to be disseminated.

Table 5: Dissemination and exploitation goals, target groups and disclosure pathways

WHAT (Dissemination goals)	WHO (Target groups)	HOW (Actions, related deliverables)
Create awareness and inform about the commitment of an international community **to move forward** along an established direction **with the design and preparation of construction** for a new research infrastructure in Europe for the benefit of scientists worldwide and with impact potentials for society and economy.	Scientists, engineers, technology companies, funding agencies, members of strategy development bodies, policy makers and lay people.	Develop a strategy (**D5.1**) and plan (**D5.4**) to communicate in simple terms **a science mission** to explore the "Origins of everything" to as wide an audience as possible. Communicate through articles, websites, social media, public events, conferences and workshops as well as face-to-face meetings. **Inform and actively engage** representatives of public authorities (**D5.2**), policy making bodies (**D1.3**), academic institutions (**D5.5, D5.6**), companies and individuals in the design and the construction preparatory steps through working meetings and face-to-face-meetings.
Build up capacities and consensus-based support in scientific, technological, financial, organisational and administrative communities that are needed **for the following phase towards construction**.	Executive management of universities and research centres, leading theoretical and experimental physicists, particle accelerator scientists, technology research program managers, executive management of companies.	**Disseminate** FCCIS physics workshop and conference **proceedings** (**M5.1, M5.3, M5.5**)* through internationally recognised publishing channels in cooperation with Springer Nature. **Disseminate drafts of physics research programme and technology R&D roadmaps through workshops (D5.5, D5.6).** **Enlarge the future circular collider study community** by defining focused R&D projects (**D1.3, M3.1, D3.2, D3.4, D4.2, D4.3, D4.4, D5.4, D5.6**) **Turn best-effort driven activities into commitments** through the **creation of a governance structure and process for** accelerator and experiment / detector **proto-collaborations (D5.3, D4.4).**
Exploit the results of this project to trigger the immediate next steps towards construction.	Science strategy makers and consultants, funding agencies, authorities of the host states at all levels.	**Inform about the conditions for the feasibility (D5.2), the regional benefit and territorial development opportunities (D4.3), the scientific and socioeconomic impact potentials (D4.2) and the funding and sustainable operation strategy based on EU smart specialisation (D4.4).**

* FCCIS Deliverables and Milestones: https://twiki.cern.ch/twiki/bin/view/FCC/FCCISDeliverables

2.2.2. Summary of potential users and uses of the project results (deliverables).

Table 6 highlights, how potential users take up the results through the dissemination and exploitation actions planned in **Table 7 to Table 15**Table 12.

Table 6: Summary of potential users and uses of the project results (deliverables).

Results	Collider based research infrastructure design concepts (**D5.6**) with an implementation strategy (**D3.3**, **D4.4**) and a scenario description for institutional stakeholders (**D5.2**)
Users	Scientific and engineering communities, policy bodies and strategy development bodies
Uptake of the results: The international FCC study member organisations and this consortium will use the conceptual design as input to the next European Strategy for Particle Physics update process. This will form the basis for definition of a preparatory project phase and to enlarge the global community of organisations that will eventually work towards the technical development and construction. The research policy bodies and funding agencies in the ERA and beyond will use the implementation, financing, and in-kind contribution strategy as input to evaluate the organisational feasibility of this endeavour. The scenario description will serve as input for EU and EC bodies as well as for national government agencies.	
Results	Collider beam optics design (**D2.1**), interaction region design (**D2.2**), booster design (**D2.3**) and the experimental characterisation of key performance enablers (**D2.4**)
Users	Particle accelerator community
Uptake of the results: Basis for the technical design. Early stage researchers enhance their skills through practical experience at operational particle accelerators, driving technology beyond state-of-the-art. Performance improvements of light sources and research particle accelerators worldwide. New software to optimise the performance of accelerator facilities world-wide. Researchers can significantly increase their publication portfolio with high-impact articles and proceedings that will be produced on the way to the deliverables.	
Results	Physics research programme (**M5.1, M5.3, M5.5, D5.5**)
Users	Particle physics community, policy and strategy development bodies
Uptake of the results: Research policy bodies will use the result as input to develop the long-term strategy in the domains of particle and high-energy physics. The world-wide physics community will use the result to define collaborative experiment and detector projects at the collider and to advance the associated R&D&I pro- grammes. Theoretical and experimental particle physicists will define targeted follow-up research pro- grammes and develop new computational software tools. Researchers can significantly increase their publication portfolio with high-impact articles and proceedings that will be produced on the way to the deliverables.	
Results	Organisational framework for collaborative work (**D5.3**)
Users	Particle physics and particle accelerator communities
Uptake of the results: Foundation for setting up proto collaborations for the development of technical proposals of particle physics experiment detectors at the future research infrastructure. Basis for the setting-up of a collaboration for the technical developments of enabling particle accelerator technologies.	
Results	Particle collider high-level design (**D2.1, D2.2, D2.3, D2.4**) and territorial placement optimisation (**D3.1**, **D3.2**, **D3.3**, **D3.4**)
Users	Technology and engineering science communities, environment and urbanism consultants, government authorities and notified bodies
Uptake of the results: Basis for the detailed elaboration of the administrative schedule to prepare the RI construction including the development of tasks in France and Switzerland to manage the environmental impacts and to develop the regional synergy opportunities. Foundation for R&I programmes that relate to energy efficiency, responsible use of resources (water, electricity), limiting the need for materials transport and landfills, landscaping, and novel architectural developments for industrial installations during the preparatory phase. Early stage researchers, engineers, environmental and urbanistic analysts acquire cross-sectoral skills including language and cultural competencies through an international and inter-disciplinary setup. Researchers can significantly increase their publication record with high-impact articles and proceedings that will be produced on the way to the deliverables. Companies can use the project as reference for further studies of large-scale engineering projects on an international scale.	
Results	Socio-economic impact analysis of the research infrastructure (**D4.1, D4.2, D4.3, D1.3**)
Users	Consortium member organisations, economists, government authorities and notified bodies, funding agencies, strategy makers, policy makers, media experts
Uptake of the results: The consortium can develop approaches to design and implement the infrastructure with added societal value generation in mind, which helps the definition a strategy for a long-term sustainable research programme. Companies can use the impact analysis models, the forecast calculation methods and the input data in other cost-benefit analysis, notably for research facilities and infrastructures. Other RIs can up- take the results to develop pathways for impact generation. Economic researchers can use the results of regional impact potentials in global value chains through smart specialisation to further develop the economic analysis methods of technology projects. This work can advance the	

economics and political sciences concerning the value of public investment. Media companies and the consortium members will develop engaging stories around the impacts of research infrastructures for fundamental science for laypersons and use the documented results during public events and in face-to-face meetings with funding agencies and policy bodies.	
Results	Innovative use cases for molasse excavation materials (**M3.1**, **D3.2**, **D3.4, D4.3**)
Users	Subsurface engineering scientists, geologists, material scientists, entrepreneurs in different product development domains, civil engineering companies, government authorities and notified bodies, environment consultancy companies
Uptake of the results: The openly published material data can be used by academia, government agencies and companies to increase their understanding about molasse and about the territorial geological situation. The materials management challenge attracts academia and industry to develop new methods to classify and separate the different molasse types on-line. Companies can use the results to develop smart tunnel boring machines. The Mining the Future® competition attracts academia and industry, potentially also individuals with plans to start a business for creating products from excavated materials. Government agencies, notified bodies, and subsurface engineering associations can include re-use cases and management approaches in guidelines and as input to the development of standards for a circular economy. The coordinator will use the results as input for working with notified bodies in France and Switzerland on regulatory frameworks to increase the possibility to re-use excavated materials in a pilot project. Specifically, Cerema, CETU, DT, EdG and MUL can provide the excavation materials management plan as an example for materials lifecycle management in subsurface engineering for further projects. Consortium members can use the results to spawn pilot projects to demonstrate the materials classification, separation, and pre-treatment with engineering companies at high TRL levels. Consortium members will use the results to train early stage researchers.	
Results	Transnational environmental evaluation framework (**D3.1**)
Users	Environment consultancy companies, subsurface engineers, engineering companies, government authorities and notified bodies
Uptake of the results: The consortium will use the result as the foundation to set up the environmental impact assessment project across France and Switzerland. It forms the requirements specification for a market survey and gap analysis of impact assessment tools. Consultancy companies can use the results to train early stage researchers how to establish environmental impact assessments across EU borders. Specifically, LD and Cerema will exploit the results for training purposes.	
Results	Communication strategy (**D5.1**) and plan (**D5.4**)
Users	Project consortium members, physicist science community, government authorities, professional communicators and media groups, independent communicators
Uptake of the results: The Future Circular Collider study community will use the strategy to develop specific communication actions for the RI construction project. It will be used to work with professional partners during the project preparatory phase and to set up the public consultancy processes in France and Switzerland. Media companies like TMFS will develop follow-up projects for communication products based on the plan. This covers content for print and audio-visual media, for the Web and social media, for arts and cultural events creating new cross-disciplinary synergies. Technology companies, academic institutes and artists can base developments on the results to actively engage laypersons in fundamental physics. This includes for in- stance, the development of novel methods to visualise the fundamental fields and their interactions to explain the origin of matter and the physical principles that make up the world around us.	
Results	Innovative authoring and publishing workflow with collaborative writing tools (**D1.2, M5.4**)
Users	Scientists, researchers, engineers from different domains as well as tool suppliers and publishing houses
Uptake of the results: Consortium members will use the workshop proceedings, the design report, and physics program report projects as training cases and as examples on how to effectively carry out large-volume scientific writing projects. Writers use the workflow to reduce the time to publish and to gain easier access to high impact publishing channels. Editors will use the workflow to increase their efficiency and therefore increase their competitiveness in terms of capacity. Publishers such as SN can use the workflow to increase their pool of writers, increasing their output, reducing their costs. A tool supplier such as Overleaf can increase its visibility and enlarge its user base due to quality and feature set increase.	

2.2.3. Detailed scientific, technical, engineering and management product dissemination plan

Table 7 Peer reviewed publications.

Means	Stakeholders
# Papers in EPJ ST, EPJ Plus, PRAB, NIM A, Frontiers in Physics, IOP conference series # Paper for the material test results of molasse (MUL, UGE, ETHZ) # Design report and physics program published open access in Springer's EPJ ST and EPJ C, respectively	Scientists relating to disciplines covered in the project including within the consortium
# Submissions to CERN Courier, Accelerating News, APS DPB Newsletter, ICFA Beam Dynamics Newsletter # Paper and conference report for "Berliner Konferenz Mineralische Nebenprodukte und Abfälle" 2021 # 4 applications to peer-reviewed journals or contributions to other peer-reviewed publications. Main journals of reference: # Industrial and Corporate Change; Journal of Economic Policy Reform; Research Policy; Technological Forecasting and Social Change; Scientometrics; Journal of Knowledge Economy; The Journal of Technology Transfer; Journal of Industry, Competition and Trade # Submissions to Springer-Nature, Scientific American, Forbes, Economist, CERN Courier, Science & Vie	Scientists, engineers and professionals from other fields
# Submissions to Research Europe, Science Business	Science policymakers and science management
# Input to the EPPSU	EU and EC

Table 8: Non-peer reviewed publications.

Means	Stakeholders
# Project deliverables as openly accessible documents on Zenodo and the project website: https://twiki.cern.ch/twiki/bin/view/FCC/FCCIS # Contribution to the TWiki site, deposits in Zenodo and CDS # Description of the placement on the Twiki site # 1 report-like publication on the possible post-LHC scenarios published e.g., in ArXiv, or SpringerBriefs in Physics (/https://www.springer.com/series/8902) # 1 PhD thesis on the socio-economic impact of open data and software developed at CERN	Scientists relating to disciplines covered in the project including within the consortium
# Documentation of the Multi Criteria Analysis approach on Twiki # Papers for BHM 12-2021 and 12-2022 # Paper in the AFTES journal (TES) # Report-like publications, e.g., on SpringerBriefs in Economics, SpringerBriefs in Regional Science or others.	Scientists, engineers and professionals from other fields
# A report in French language provided to the authorities in both host states about the method and results of the placement # A report in French language provided to the authorities in both host states about the excavation material management method. # 1 report that details key policy recommendation on how the FCC construction and operation project is best set up to ensure generation of regional impacts	Government authorities and institutions
# 1 report on the benefits of FCC of the regional technology/science poles and infrastructures # 1 paper or report-like publication on the future potential contributions of FCC in the field of open data and knowledge sharing, considering three specific case studies (Zenodo, ProtonMail, and Indico)	Science policymakers and science management
# Yearly contribution to REPEC CSIL working paper series (open access)	Professional organisations and interest groups
# 1 paper on new estimates of Social Discount Rate in Europe, published in REPEC CSIL working paper series (open access)	EU and EC

Table 9 Active conference participation.

Means	Stakeholders
# FCC Week, IPAC (JACoW proc.) # Presentation on the progress of the placement during the annual FCC weeks # Presengtation for the material test results of molasse during the AFTES congress # Communication on the material management plan principles at the AFTES Congress # Dedicated session at the AFTES congress (or specific exhibition) # Contributions on socio- economic impact analysis during the FCC weeks # Proceedings resp. topical special issues published by SN for 3 FCC Week conferences	Scientists relating to disciplines covered in the project including within the consortium
# Presentation at a territorial technical conference organised by Cerema. # Presentation at "Berliner Konferenz Mineralische Nebenprodukte und Abfälle" 2021 # Report on the actual design at TBM-DiGs 2022 # Presentations at an international conference for economists (e.g., Regional Studies Association, European Regional Studies Association, European Evaluation Society, International Schumpeter Society Conference, Geography of Innovation, Regional Science Association, DRUID) # Presentation of the project at a territorial technical conference (CTT) organised by Cerema	Scientists, engineers and professionals from other fields
# Invitation of companies relevant for the preparatory and potentially the construction phase to inform about the actual placement of the research infrastructure	Industry representatives and companies
# Presentations at an international Conference on Research infrastructure (e.g., the biannual International Conference on Research Infrastructures (ICRI), the European R&I Policy Evaluation Conference, ESFRI events)	Science policymakers and science management
# Invitation of companies relevant for the preparatory and potentially the construction phase to the annual FCC week, to inform about the socio-economic impact # Information on the Cerema website. Relay of these articles to the relevant professional spheres	Industry representatives and companies
# A presentation at an international conference on Cost-Benefit Analysis, e.g., the European Conference of the Society for Benefit-Cost analysis in 2021 (October 2021, https://sbcaec2021.com/)	Professional organisations and interest groups

Table 10: Active workshop participation.

Means	Stakeholders
# Workshop proceedings on JACoW # Workshop "Reuse of Tunnel excavation material" October 2022 (Mining the future competition results) # Proceedings resp. topical special issues published by SN for physics workshops	Scientists relating to disciplines covered in the project including within the consortium
# AFTES Webinar dedicated to the review of the FCC project stage (in French)	Scientists, engineers and professionals from other fields
# A presentation at the webinar "Keeping pace with CBA: Investment appraisal for the Next Generation EU" organized by CSIL in September 2021	Professional organisations and interest groups
# A contribution (e.g., poster or other communication material) at European policy events, such as the annual European research and innovation days, the EU Open Data days	EU and EC

Table 11: *Face-to-face meeting / networking event.*

Means	Stakeholders
# Zoom and in person, meeting minutes available online # Provide information about the "avoid-reduce-compensate", multi-criteria analysis, eco-design, environmental risk management and placement progress in project working meetings, in particular those ones to gather input for the placement work #Zoom and in-person, meeting minutes available of the MATEX working group # End-of-event brief roundtable summary to be either published as a single jointly authored journal article or disseminated as a short video	Scientists relating to disciplines covered in the project including within the consortium
# Meetings twice per year with swiss and French government representatives to inform about the placement progress and results # Regular meetings with regional administration offices to inform about the progress of the placement and to discuss territorial constraints # Periodical regional networking events dedicated to policy makers and socio-economic stakeholders in France	Government authorities and institutions
# Information about the placement in the frame of project steering committee and advisory board meetings that include decision takers from other research organisation # Information by project leaders to top management of CERN, CEREMA, CETU about the placement Information about the excavated material management plan in the framework of steering committee ad advisory board meetings	Science policymakers and science management
# Information to key infrastructure construction, supply and management companies during industry days at CERN, during FCC weeks	Industry representatives and companies
# Reports to the FCCIS Executive Board # Schedule to inform selected EC representatives about the result of the scenarios that are retained for implementation	EU and EC

Table 12: *Training.*

Means	Stakeholders
# Training to technical students at CERN and MUL, interns at CETU (e.g., on the eco-design approach)	Scientists relating to disciplines covered in the project including within the consortium
# Explanation of the method for territorial optimization in form of presentations	Scientists, engineers, and professionals from other fields
# Publication of training programs in Research Europe and Science Business	Science policymakers and science management

Table 13: *Newsletters and announcements.*

Means	Stakeholders
# Contributions to CERN Courier, Accelerating News, APS DPB Newsletter, ICFA Beam Dynamics Newsletter # Flyer for opening the Mining the Future contest # Social media campaign for Mining the Future contest # A contribution to the CERN Courier Magazine on specific results of the socio-economic impact analysis # Contributions to CERN Bulletin and CERN Courier Interactions.ORG newsletter and Symmetry Mailing Lists	Scientists relating to disciplines covered in the project including within the consortium
# Contribution in the FCCIS Newsletter, FCC Newsletter and FCC leaflets # Relay of articles on the Cerema website # Regular news on the CETU website # Contributions to CERN Bulletin and CERN Courier Interactions.ORG newsletter and Symmetry Mailing Lists	Scientists, engineers and professionals from other fields

# Contribution in the FCC newsletters about the progress on the placement # A contribution on the population's willingness to pay for CERN in a post-COVID era, e.g., on SpringerBriefs, or science policy magazines (e.g. Euroscientist https://www.euroscientist.com/)	Government authorities and institutions
# A contribution per year in the FCCIS periodic newsletters on the progress of the socio-economic impact analysis	Science policymakers and science management
# Relay of articles on the Cerema website	Industry representatives and companies
# 3 posts per year on CSIL social media page (Linkedin, Twitter) and at least 1 news per year on CSIL website on specific results of the socio-economic impact analysis # A contribution at the European Evaluation Society newsletter (EuropEval Digest)	Professional organisations and interest groups

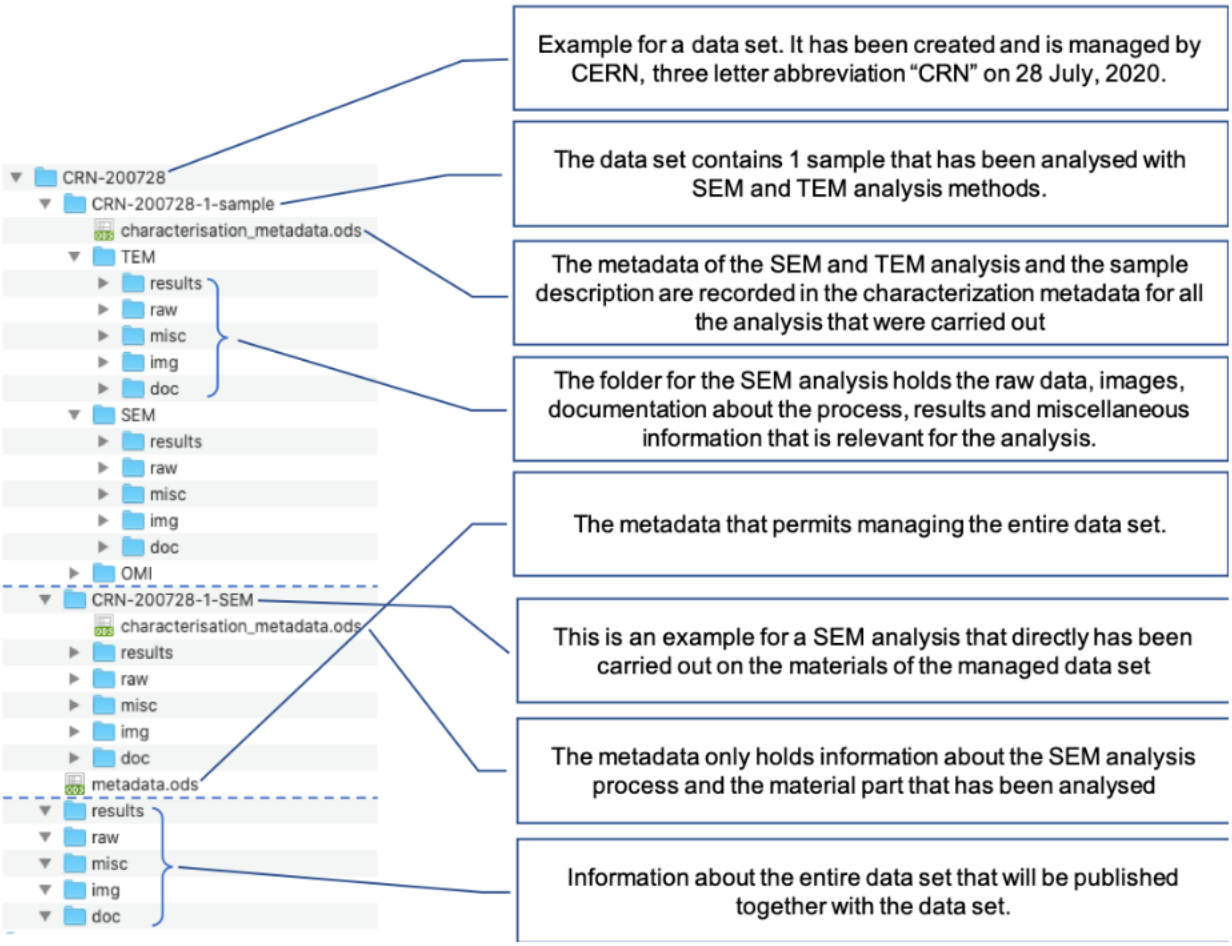
Table 14: Dedicated information materials.

Means	Stakeholders
# Information brochure about the placement scenarios, the method used to come to this placement # Input documents for the update of the Plan Directeur Cantonal (PDCn) in Geneva, Switzerland # FCCIS brochures and videos	Government authorities and institutions
# A publication of strategy document for implementation, financing and in-kind contributions (open access) # Publicly available open collaboration agreement framework	Science policymakers and science management
# A template description of the FCC project to be used in procurement actions and tenders informing companies about the project, its goals and scope # 1 one-pager or other short communication material on the benefits for CERN procurement firms # Mining the future challenge marketing campaign	Industry representatives and companies
# An information brochure about the placement scenarios, the method used to come to the placement.	EU and EC

Table 15: Open data platforms.

Means	Stakeholders
# Placement data put on open data and geographical information systems # Data on forecasted scientific publications and other scientific outputs on CERN/FCC made available on open access repositories and platforms (e.g., Zenodo)	Scientists relating to disciplines covered in the project including within the consortium
# Data on the results of the CERN survey to former students, associated researchers or employees and CSIL analysis of salaries made available on open access repositories and platforms (e.g., Zenodo or other community open data repositories)	Scientists, engineers, and professionals from other fields
# Data on forecasted number of visitors at CERN and their spending profile made available on open access repositories and platforms (e.g., Zenodo)	Government authorities and institutions
# Anonymised data used for the estimation of the industry Utility/Sales ratio made available on open access repositories and platforms (e.g., Zenodo)	Industry representatives and companies
# Data for the estimation of the European population willingness to pay for CERN made available on open access repositories and platforms (e.g., Zenodo) # Data for the estimation of the Social Discount Rate in Europe made available on open access repositories and platforms (e.g., Zenodo)	EU and EC

3. ANNEX 1



(Back to top: Folder structure)

4. ANNEX 2

Specific objectives and the associated, expected outcomes of the FCCIS project.

ID	Objective	Planned outcome
O1	**Design a circular luminosity frontier particle collider with a research programme to remain at the forefront of research.**	**RI design published** in Springer-Nature (SN) EPJ. **Physics research programme** guiding the machine development and showing the experimental research opportunities **published** in SN EPJ. **Product breakdown structure published** as milestone for detailed **cost estimates**, project **implementation risk** database, **implementation plans** and a structured socio-economic impact analysis.
O2	**Demonstrate the technical and organisational feasibility of a 100 km long, circular particle collider.**	**Accelerator beam optics** (result of O1) **demonstrated at the particle accelerators made available by CERN, DESY, INFN, KIT** and **BINP**. **Layout and placement of the infrastructure optimised** as result of implementing a standard environmental management process[1]. **Strategy for balanced territorial development, international funding and in-kind participation published.**
O3	**Develop an innovation plan for a long-term sustainable research infrastructure that is seamlessly integrated in the European research landscape.**	**Develop a project scenario for the implementation of a new research infrastructure** that delivers long-term service for a worldwide science community. User community engagement and capacity building, cost effectiveness and resource-responsibility lie at the heart of the **sustainability concept**. **The published physics research program** and **draft proposals for detector projects** ensure that the scientific user community exploits the facility from the start and defines the research services at international level. The collaboration agreement includes **a long-term intent for the curation, preservation and provision of access to the data collected** taking into account the shared use of ICT infrastructures among different European research communities. **Produce a plan for funding and collaborative construction** with public-private networks and **collaborative operation**.
O4	**Engage stakeholders from different sectors of society.**	**Published communication strategy** as the foundation for public acceptance of a new, large-scale research infrastructure. **A plan** to **raise curiosity** for a new science mission to elucidate the "Origin of Everything®", to bring the Standard Model of Particle Physics **to as wide as possible audience** and to **identify ways to actively engage citizens**. **Engagement of policy makers and funding agencies** for a project preparatory phase **through information meetings**, the delivery of a project scenario **briefing book** and the creation of a **high-level advisory committee** concerning the development of socio-economic impact pathways.
O5	**Demonstrate the role and impact of the research infrastructure in the innovation chain focusing on responsible resource use and managing environmental impacts.**	Delivery of a **socio-economic impact analysis**, showing how the RI can contribute with innovation capabilities to technological leadership and how it can address specific societal challenges such as connecting economic and environmental gains through a circular economy (e.g., energy recovery, integration of renewable energy sources, excavation materials re-use). **Consideration of EU smart specialisation in the plan for funding and in-kind contribution with proposals for co-construction with companies**. Show through the **optimised placement scenario** how the environmental impacts will be limited. Showcase responsible resource usage through a **management plan for waste reduction and reuse pathways** that include competitiveness opportunities for constructors, as the aims[2] in the H2020 work program state.

[1] CGDD and Cerema, 2018, https://www.ecologique-solidaire.gouv.fr/sites/default/files/Théma%20-%20Guide%20d'aide%20à%20la%20définition%20des%20mesures%20ERC.pdf
[2] http://ec.europa.eu/research/pdf/factsheet_focus-area_h2020.pdf

4) (back to top: Dissemination and exploitation goals, target groups and disclosure pathways

5) Plan for dissemination of results:

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