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ISABEL

– *Improving the sustainability of the European Magnetic Field Laboratory*

D4.5 FINAL DATA MANAGEMENT PLAN
Open Research Data Pilot

Version	Deliverable	Modifications	Date	Authors
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Document abstract

This document represents the **Final Data Management Plan** (DMP) of the EMFL. It addresses data generated in the course of EMFL's scientific and technological activities, and administrative data collected as part of the management of the access to the EMFL facilities by external and internal users. The DMP for the scientific use cases follows the Guidelines on Data Management in the Horizon 2020 document version 3.0 dated 26 July 2016, and, by that, implements all FAIR principles. These guidelines state:

"Participating projects will be required to develop a Data Management Plan (DMP), in which they will specify what data will be open."
As such, this DMP focuses primarily on data sharing and re-using and in particular on the following issues (Annex 1 of the H2020 DMP Guidelines):

• What types of data will the project generate/collect?
• What standards will be used?
• How will these data be exploited and/or shared/made accessible for verification and re-use? If data cannot be made available, explain why.
• How will these data be curated and preserved?

EMFL acknowledges that DMPs are living documents that evolve based on user feedback, technological innovations, and guidance from research communities and funding agencies. The EMFL Data Management Policy and Plan will be reviewed and updated regularly to ensure alignment with the FAIR principles amidst a data management landscape in constant flux.

In the course of the ISABEL project, regular updates to this data management plan were made according to the following draft schedule:

- First version circulated among the facilities in month 6 (Deliverable 4.3 - April 2021),
- Updated Data Management Plan submitted in month 24 (Deliverable 4.4 - October 2022).
- Final Data Management Plan to be submitted in month 60 (Deliverable 4.5 - October 2025).

Preamble

The EMFL endorses the principle of open access to research data and the facilities support its staff and guests to fulfill the requirements of funders and of the scientific community. To this end, they will provide the necessary infrastructure for data management and will regulate the access to data within a well-defined policy. Open access to research data should be ensured wherever possible following the path of citable data publication. To this end, general principles of the EMFL data policy have to be defined and agreed on. This includes well-defined rules for the management of scientific data and analysis software, such as ownership, storage, curation and access to the data. The responsibility for the data management at a research facility must be clearly defined and documented. For the data from proprietary research, clear data-handling procedures have to be defined. This includes intellectual property rights as well as all licensing and ethical issues.
This Data Management Plan will undergo continuous updates also after the end of the ISABEL project; members that will join the EMFL in the future will be required to comply with updated versions of this DMP.

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1. Introduction

This Data Management Plan (DMP) addresses two distinct sets of data to be managed by the EMFL consortium:

- **Administrative data**: Data collected in the course of the management of the European Magnetic Field Laboratory and its member facilities,

- **Scientific and Technical Data**: Data collected during the development and the execution of the scientific and technical activities at the EMFL facilities.

These two types of data will be treated separately in this document. Details on both sets of data are given below.

2. EMFL administrative data

This section describes the plan for the data which are to be managed for the allocation and management of the access to the EMFL facilities. Access to the EMFL facilities' research infrastructures is granted to external and internal users (mostly user teams) after the user's research proposal is rated by the EMFL selection committee, as well as the board of directors in case of particular access procedures such as fast-track, technical or industrial-user access. Several novel access procedures are under test in the frame of the ISABEL project.

The aforementioned user-proposal ranking process is managed and administrated by a coordination team, which also gathers and stores contact details (name, email address, role within organization / company, organization / company name, and organization / company postal address) provided by individuals representing organizations and companies interested in access to the EMFL facilities' infrastructures while handing-in experimental proposals. In detail, the following list of parameters is curated within the proposal process.

DATA	EXPLANATION	COMMENT
User ID	Unique ID	Automatically created
Link User ID	Link between former and new account	
ts	Date & time of account creation	
User Check	Validation of user account	
User Title		Compulsory when user creates his/her user account
User Last Name*		
User Firstname*		
User Nationality		
User Birthyear**		

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Gender**		*Compulsory when a user adds participants on proposal **not mandatory
Affiliation Institution*		
Affiliation Department*		
Affiliation Address		
Affiliation Postcode		
Affiliation Town		
Affiliation Country*		
User Email*	Login to user account, email contact	
Password	Password for login to user account	
Send Mail	Mailing list	
Phone		Optional
Mobile Phone		
Type of Institution	University, Research institution, Small and medium-sized enterprise, Private, Other	Only Admin form
Research Status	Professor, Researcher, Postdoc, Student, Master student, Other	
Science Field	Physics, Chemistry, Life sciences & Biology, Engineering & technology, Material science, Other	
New User	Y/N	

The access of these data is restricted by the following scheme:

- Principle Investigators (PI) and participants on proposals have access to all administrative data except for the 'User Birthyear' and 'Gender' that are visible only to the user himself or herself.
- The EMFL user-access managers, the Board of Directors (BoD), and the IT team in charge of the EMFL database have access to all administrative data.
- The facilities' administrations have access to 'User First Name', 'User Last Name', 'User Email', 'Phone', 'Mobile Phone', 'User Birthyear', 'Gender', 'User Nationality', 'New User', 'Science Field', 'Research Status', 'Affiliation Institution', 'Affiliation Country', and 'Type of Institution'.
- Local contacts and the members of the Selection Committee (SelCom) have access to 'User First name', 'User Last name', 'User Email', 'Phone', 'Mobile Phone', 'Affiliation Institution', 'Affiliation Address', and 'Affiliation Country'.

The administrative data are used as a base for anonymized statistics, summarizing the level of activities of the EMFL, and are to be reported anonymously in the mandatory deliverable reports. Beyond the summary statistics reported in the project deliverables, such information

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will be restricted to the consortium members. For the protection and professional processing of personal data, EMFL will strictly obey the EU General Data Protection Regulation (GDPR), the EU Data Protection Law Enforcement Directive, national, and in case regional data protection rules as well. EMFL are aware of cybersecurity risks from Artificial Intelligence (AI) and machine-learning tools, particularly when offered by commercial providers and hosted on servers outside the EU. Examples for applications on administrative data are: Data-set extraction, sorting of file entries, automated translation and text-generation services, and the automated transcription of video calls.

To prevent the exposure of confidential information when handling administrative data, EMFL will only use external AI services if the provider has signed the 'Code of Practice for General-Purpose AI Models (GPAI)', as published on the following EU webpage: https://digital-strategy.ec.europa.eu/en/policies/contents-code-gpai.

Physical data carriers containing administrative data (printouts, USB sticks, hard disks etc.) must be disposed of under strict observation of data-protection rules.

Administrative data will be maintained beyond the lifetime of the ISABEL project, e.g., as email lists.

Exchange of administrative data with regional facilities and external partners is described in Sect. 4 (see Guideline Data sharing).

3. Scientific and Technical Data

Scientific data are collected by the numerous scientific activities of the member's laboratories. These data, we assign to the following categories:

- **raw:** machine data streams (saving is not mandatory, need not to be saved),
- **primary:** transformed / evaluated machine data (must be saved),
- **secondary:** published data / graphs etc. (must be saved).

Primary and secondary analyzed scientific data are derived from the **raw data** by use of commercial or self-developed data-analysis software. Scientific data also result from the simulation of physical properties according to theoretical models.

Technical data are generated by performing design studies and monitoring of the research infrastructures, such as magnets as well as pulsed- and continuous current generators. Data are generated further in numerical simulations in the development of new infrastructure components.

Both, **secondary analyzed scientific and technical data,** are intended for publication or, in selected cases, for patenting.

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4. Description of EMFL Data in the framework of the Horizon-2020 Annex 1 Guidelines

In this section, we answer directly to the Horizon-2020 Guidelines. This **Data Management Plan** includes initial examples for scientific and technical data sets, others will be added during subsequent document revisions.

- **Guideline: Data Set reference and name**

This **Data Management Plan** (DMP) refers to the data sets generated by the three EMFL partner laboratories. These are:

- Laboratoire National des Champs Magnétiques Intenses (LNCMI) in Toulouse and in Grenoble, CNRS;
- HFML-FELIX, Nijmegen, and
- Dresden High Magnetic Field Laboratory (HLD) at HZDR.

For the purpose of this plan, we refer to this data set as "The EMFL Data".
In terms of data preservation, the software, its environment, and associated documentation must also be preserved (see below).

Further details (and, most important, the EMFL laboratories data management policies) will be further developed as ISABEL deliverable D4.6 and published on the EMFL website and on the EMFL partner websites, with entries for each of the above partners:

- https://emfl.eu/user-guide/
- https://www.hzdr.de/
- https://www.ru.nl/rdm/vm/policy-documents/
- http://lncmi.cnrs.fr/

- **Guideline: Data set description**

The three laboratories referenced above have clear scientific goals as described in their Missions, on the EMFL website (https://emfl.eu/about-emfl/) and via their own websites,

- https://lncmi.cnrs.fr/en/laboratory-objectives-and-missions/
- https://www.hfml-felix.nl/en/about-us/
- https://www.hzdr.de/hld

Data are generated by multiple sources:

Scientific raw, primary, and secondary data as well as **technical data** are generated as defined in section 3;

Administrative data are generated while processing and evaluating the experiment proposals handed in by the users as well as in the course of the general handling of the EMFL facilities.

- **Guideline: Standards and Metadata**

Scientific primary and secondary data as well as **technical data** will be curated in well-defined formats, which are typically experiment-specific, although globally similar. EMFL primary and secondary data are generated in open and free data formats, readable by

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common-use programs such as standard text editors. For further analysis of the raw data, custom-made programs are to be made available by the EMFL, access-restricted only where intellectual property rights have to be obeyed. **Associated metadata** will be curated either within the raw-, primary- and secondary data files, within an associated online catalogue, or within both.

Administrative data will be curated in well-defined formats generated by commercially available standard administrative software. **Associated metadata** will be curated either within the data files, or within an associated catalogue, or within both.

- **Guideline: Data sharing**

The EMFL member laboratories already possess individual policies for making data available, including reasonable embargo periods, together with the provision of the necessary software, documentation and other tools for re-use.

Onsite data transfer:
In case, users participate onsite at performing their proposed experiments at EMFL facilities, data are often transferred from the IT infrastructure of the laboratories to mobile storage devices supplied by users.

E-mail or download data transfer from local repositories:
In addition and for projects operated in remote and mailed-in sample access mode, data are either transferred by e-mail or by online-data transfer via facility repositories described below.

Science cloud data transfer:
In future, we will also make use of the collaborative effort and will utilize the **European Open Science Cloud, www.eosc-portal.eu.**

Each EMFL facility is in charge of the curation of results stored in EMFL repositories. These repositories are:

- **Laboratoire National des Champs Magnétiques Intenses (LNCMI-CNRS) Toulouse:**
  Primary and secondary data stored on CNRS Networked Storage, open data are published in a dedicated repository on https://entrepot.recherche.data.gouv.fr/dataverse/lncmi , as described in detail in section 5 below.

- **HFML-FELIX, Nijmegen:**
  Primary and secondary data are stored on networked storage. Data associated to published manuscripts are published in data sharing collections on https://data.ru.nl/ .

- **Dresden High Magnetic Field Laboratory at HZDR (HLD-HZDR):**
  - 'CNS' and '\\filet' file systems of HZDR, as described in detail in section 5 below.
  - The "Rossendorf" (HZDR) data repository, https://rodare.hzdr.de

Data will be released through links provided at the user portal of the EMFL website, http://emfl.eu/opendata, leading to the access portals of each facility website (such as next- or ownclouds). Access to this portal will require registration.

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The data will be published with accompanying software and documentation, together with a metadata catalogue in order to fully implement the FAIR principle. If intellectual property rights should prohibit EMFL to publish software necessary for a re-evaluation of raw data, the software will be named, and a reference will be given how the software can be acquired.

Administrative data and metadata which contain personal information about members of EMFL user groups shall not be published, in particular, if their publication violates EU data-protection regulations (GDPR). Personal information shall be used only in case the user (i.e., the owner of the data) has given consent to EMFL to use his or her data.

Professional data given in experiment proposals will be passed on within the administration of EMFL, its facilities' and its regional facilities' administrations, or the administrations of partners, only after the recipients of the data warrant a diligent observation of the EU GDPR, the EU Data Protection Law Enforcement Directive, national, and if applicable, regional data protection rules. Data safety standards, data and software protection will be handled according to EU standards.

EMFL, its facilities, and its regional facilities increasingly apply tools using Artificial Intelligence (AI) and machine learning. Examples for such applications are automated data handling, text-translation and text-generation services, AI-supported computer programming, or automated transcription of video calls. EMFL are aware that using external AI services always means an exposure to cybersecurity risks, particularly when hosted on commercial servers outside the EU.

To prevent disruptions in IT services, data loss or corruption, or the exposure of confidential information, EMFL will diligently follow the EU AI Act (Regulation (EU) 2024/1689) and the 'Ethics Guidelines For Trustworthy AI' by the EU Commission's Independent High-Level Expert Group on Artificial Intelligence.

EMFL will not use external AI services, unless the provider has signed the 'Code of Practice for General-Purpose AI Models (GPAI)', as published on the following EU webpage: https://digital-strategy.ec.europa.eu/en/policies/contents-code-gpai .

All materials are shared, e.g., with **Open Science licenses** (more precisely: the Creative-Commons CC0 Dedication (http://creativecommons.org/publicdomain/zero/1.0/) to enable others to build on the results of these experiments. The EMFL's scientific users are required to waive copyright and related rights together with all associated claims and causes of action with respect to the **primary** and **secondary** data and associated metadata.

- **Embargo periods**

Concerning an embargo period, access to primary and secondary data and the associated metadata is restricted to the researcher/team who generated the data, for a period of **three years after the end of the experiment**.

After embargo, the PI will be asked, if ok that data will be made public. Thereafter, the data will become openly accessible on third-party's demand with the EMFL facilities acting as custodian. Either the local contact or the user has to decide whether data can be made public on demand.

Any user who wishes to maintain the restricted access to his data for a longer period will be required to make a special case to the EMFL-facility management. By that the embargo time can be prolonged on reasonable request.

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Data can always be made openly accessible earlier on simple request of any member of the experimental team, if no other member objects. Appropriate facility staff members (e.g., instrument scientists, computing group members) have access to any EMFL-facility curated data or metadata for facility-related purposes. EMFL will ensure that they will preserve the confidentiality of such data.

Any member of the user group has the right to create and distribute copies of his/her **primary** and **secondary** data.

- **Guideline: Archiving and preservation (including storage and backup)**

(Guidance: Description of the procedures that will be put in place for long-term preservation of the data. Indication of how long the data should be preserved, what is its approximated end volume, what the associated costs are and how these are planned to be covered.)

Primary and secondary data and associated metadata will be stored by the EMFL facilities for at least ten years. Commercial users are entitled to apply with the EMFL coordination team for a deletion of their primary and secondary data before the end of the ten-year storage period. **Administrative data, metadata,** and **technical data** remain subject to the ten-year data storage period in any case.

Ten years after data are generated, a coordination team will decide about their deletion. At least three calendar months before the deletion process is initiated, the members of the respective user group will be informed by the coordination team by message to their e-mail address(es) about the forthcoming deletion of their data. Before the deletion process is initiated, a protocol based on the metadata must be made on which data will be deleted.

As a general rule, data that are created in the course of activities at EMFL will be copied to institutional and/or discipline-specific repositories for long-term preservation, curation and sharing. Data repositories (e.g., the HZDR CNS repository) are in general requested to self-certificate according to ISO 16363 (*ISO 16363:2012 defines a recommended practice for assessing the trustworthiness of digital repositories. It is applicable to the entire range of digital repositories. ISO 16363:2012 can be used as a basis for certification).* Such a self-certification is highly desirable and should be aimed for in the framework of the EMFL DMP.

Costs related to archiving and preservation of data are covered by stakeholders (HZDR, RU) or partners (LNCMI). As an example, for LNCMI-T the approximate maintenance costs are 2.000 Euros per year and 15.000 Euros renewal costs every 5 to 10 years.

5. Data Management Plans / Status for the four EMFL facilities

In this section, we give a description of the status of the Data Management at the three EMFL laboratories, which includes four EMFL facilities. The description is categorized in preservation aspects as mentioned in Horizon-2020 Annex 1.

5.1 Laboratoire National des Champs Magnétiques Intenses (LNCMI-CNRS)

- **Preservation Aspects: Data; Archiving and Preservation including storage and backup; Bit Preservation**

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Toulouse:
Scientific primary and secondary data from pulsed-field experiments are manually copied from experiment-based computers onto a networked storage of 4 TB by the local contact. The data are organized on a per proposal basis. These data are stored on a RAID-5 redundant array of independent disks with journaling. The technical data are stored after each pulse on a 1 TB network storage and are backed up manually.
Grenoble:
Scientific raw data from resistive field experiments are stored locally and are accessible to the user group during their experimental stay. The technical data are stored in a database each second and are backed up automatically. The data are organized as a per-proposal basis. These data are stored on a RAID-1 with journaling.

- **Preservation Aspect: Value**

LNCMI generates typically 95 scientific papers and 3 internal PhD theses per year.

- **Metadata collection:**

Experimental metadata are collected either on CNRS standard paper lab notebooks, or on LNCMI instance of electronic lab notebook (ELN) on https://lncmi.cle.cnrs.fr/. This ELN is based on an open-source software (ElabFTW) and is hosted on a SecNumCloud provider.

- **Open data publication :**

To ensure a FAIR dissemination of the open data produced in LNCMI, a dedicated space has been created on the French government data portal:
https://entrepot.recherche.data.gouv.fr/dataverse/lncmi .

LNCMI is developing in-house capabilities for long-term preservation, curation and sharing of the data deposited in this repository.

- **Preservation Aspect: Software**

Scientific primary and secondary and technical data at LNCMI are generated and analyzed by various experiment-specific software tools which are often home-written, but can also be proprietary commercial products. Some tools are available as open-source software on https://gitlab.in2p3.fr/himagnetos to allow visitors to visualize and modify analysis parameters of experiments.

5.2 HFML-FELIX, Nijmegen

- **Preservation Aspects:**

Data; Archiving and Preservation including storage and backup; Bit Preservation

Depending on the experiment, **scientific primary and secondary data** and **technical data** are stored on measurement personal computers (PCs) during the measurements, and copied to daily backed-up network storage, which is maintained by Radboud's CNCZ department. On individual basis, the data is also stored on office personal computers to facilitate easy analysis.

Analyzed scientific and technical data, administrative data and **results of simulations** are stored on an individual basis on either desktop PCs or daily backed-up network drives maintained by CNCZ. Data which are part of a published paper or PhD thesis are also stored at a dedicated file system https://data.ru.nl/ .

- **Preservation Aspect: Software**

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Scientific primary and secondary and technical data at HFML-FELIX are generated by various experiment-specific software tools which are often home-written but can also be proprietary commercial products.

- **Preservation Aspect: Value**

HFML-FELIX generates typically 70 scientific papers and 6 internal PhD theses per year.

5.3 Dresden High Magnetic Field Laboratory (HLD-HZDR)

- **Preservation Aspects: Data; Archiving and Preservation including storage and backup; Bit Preservation**

Scientific raw data and technical data from pulsed-field experiments are automatically written onto an SSD storage file server called 'CNS' after each magnet pulse. EMFL data sources have write-only permission to prevent accidental data deletion. CNS has a storage size of 500 Terabyte, of which currently 20 TB are reserved for EMFL data, and is operated by HZDR's Department of Information Services and Computing. For redundancy, snapshots of the current file status are stored on back-up systems twice daily, at 1 p.m. and at midnight CET.

Data stored on CNS for a longer period of time and no longer requested for analysis are regularly archived on an LTO7 data-tape repository (capacity 8 Petabyte) with expected 30 years of readability.

The volume of EMFL data stored on CNS approximates 200 GB per year.

A web-based log-book system is under development aiming to improve metadata collection and monitoring. Access is grouped into three levels of hierarchy: Operators, facility managers, and administrators. Operators can open a data set, assign it to a user proposal, and modify the data set until a facility manager closes the proposal. Administrators have read-only access. For personal laboratory notes, HLD-HZDR encourage their personnel to use Jupyter notebooks with data storage on HLD-HZDR's '\\filet' system.

Analyzed primary and secondary scientific and technical data, administrative data and **results of simulations** are stored on the '\\filet' system, which consists of several redundant hard-disk arrays distributed to several physical locations, with a total capacity of currently 4 Petabyte. Automated backup 'snapshots' are initiated at regular time intervals. The '\\filet' system is operated by HZDR's Department of Information Services and Computing. Migration of data from \\filet to the LTO7 data-tape repository is possible by manual activation.

- **Preservation Aspect: Documentation**

Scientific raw data and technical data from pulsed-field experiments are automatically written onto an SSD storage file server called 'CNS' after each magnet pulse. EMFL data sources have write-only permission to prevent accidental data deletion.

Analyzed primary and secondary scientific and technical data, administrative data and results of simulations are stored on the '\\filet' system which consists of several redundant hard-disk arrays distributed to several physical locations. Automated backup 'snapshots' are initiated at regular time intervals.

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Closer details on the 'CNS' and '\\filet' systems are given in the above section 'Preservation Aspects:
Data; Archiving and Preservation including storage and backup'.

- **Preservation Aspect: Software**

Scientific primary and secondary and technical data at HLD-HZDR are generated by numerous instrument-specific and infrastructure-specific software tools which are partly subject to regulations concerning intellectual-property rights, patent rights and copyrights. Instrument-specific and infrastructure-specific software at HLD-HZDR is developed on terminal computers, and once finalized, stored on the '\\filet' system. This file system and its regular automated backups are described in closer detail in the above section 'Preservation Aspects: Data; Archiving and Preservation including storage and backup'.

Similarly, software tools for the **analysis of scientific and technical data, for generating results of simulations, and for generating and management of administrative data** are to a large extent copyright-protected commercial products. Licenses are required for most of the latter software tools, and they are predominantly distributed to the HZDR network by the HZDR's Department of Information Services and Computing, who also diligently manage the software preservation. To prevent the exposure of confidential information when handling administrative data, EMFL will only use external AI services if the provider has signed the 'Code of Practice for General-Purpose AI Models (GPAI)', as described in section 2.

Software, which is necessary for interpretation of raw and primary data, will be either published by HLD-HZDR as mentioned in section 'Guideline: Data sharing', or if intellectual-property rights do not allow a publication a reference to a commercial source for the necessary software will be given.

- **Preservation Aspect: Value**

Analyses, scientific publications (from external users and from in-house research), Bachelor, Master and PhD theses continue to be produced. During the data-taking period 2013-2020, the average numbers of scientific output are: Journal publications ≈ 60 / year, PhD theses ≈ 3 / year (in-house only), Master theses ≈ 2 / year (in-house only), Bachelor theses ≈ 1 / year (in-house only). External PhD, Master and Bachelor theses, which made use of data that were generated by EMFL experiments, are not included in these numbers.

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6. Summary

Here, we present the Updated Data Management Plan (DMP) and report on the status of data management for the four EMFL facilities, who each are part of stakeholders that already had elaborate Data Management Policies prior to the start of the ISABEL project. Our DMP is focused on data preservation and data sharing for re-use in accordance to the FAIR principle. We have developed the Updated and the Final Data Management Plan (DMP) by incorporating all the experience gained in all scientific, technical, and administrative activities for internal and external users during the ISABEL project into the initial version of the DMP. We have also used here all the new experience we have gained in the context of multiple challenges associated with the Corona pandemic and the related increased use of remote and mailed-in-sample experiments as well as the consequent request for online repositories and remote data transfer. We acknowledge that we are aware of the novel cybersecurity risks posed by the increasing use of information-technology services hosted on servers outside the EU, such as AI tools and remote data-transfer solutions.
Whilst these plans may be more detailed than required by the H2020 guidelines, they nevertheless reflect the concrete work in these areas and provide a solid basis, on which data management-related work in the EMFL project can be evaluated.