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DELIVERABLE REPORT

WP1 Project management

D1.1

Data Management Plan

Due date

M6

This initiative has received funding from the EU's H2020 framework program for research and innovation under grant agreement n. 101007417, NFFA-Europe Pilot Project

PROJECT DETAILS

PROJECT ACRONYM	PROJECT TITLE
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Dr. Laura Esposito (CNR)

DELIVERABLE DETAILS

DELIVERABLE ID	DELIVERABLE TITLE
D – D1.1	Data Management Plan

DELIVERABLE DESCRIPTION

The document presents the NEP Data Management Plan (NEP-DMP), and describes the measures envisaged to efficiently manage the Research Data collected and generated during the project.
The NEP-DMP is intended to be a *living document* in which information can be made available on a finer level of granularity through updates as the implementation of the project progresses and when significant changes occur. The document is therefore versioned in order to keep track of changes and improvements.
The NEP-DMP describes the standards and methodologies for the collection and generation of Research Data that will be applied throughout the duration of the project, as well as the conditions for publishing such data. This document aims to facilitate the creation of common understanding and, where possible, common practices.

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AUTHORS

I. Modolo (Elettra-Sincrotrone Trieste)
E. Osmenaj (CNR)
M. Panighel (CNR)
S. Cozzini (AREA Science Park)
E. Piacini (eXact lab)
E. Narducci (CNR)
G. Brandino (eXact lab)

PERSON RESPONSIBLE FOR THE DELIVERABLE

Ettorina Piacini (eXact lab)

NATURE

ORDP: Open Research Data Pilot

DISSEMINATION LEVEL

☒ P - Public

☐ PP - Restricted to other programme participants & EC: (Specify)

☐ RE - Restricted to a group (Specify)

☐ CO - Confidential, only for members of the consortium

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FOR MORE INFO PLEASE CONTACT

Irene Modolo
Elettra-Sincrotrone Trieste
Strada Statale 14 - km 163,5 in AREA Science Park,
34149, Basovizza, Trieste, Italy

irene.modolo@elettra.eu

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2	07/04/2022	E. Osmenaj I. Modolo M. Panighel E. Narducci	Corrections after 6 months from the first version submitted (available for consultation at https://doi.org/10.5281/zenodo.6984643): • Removed references to personal data and the Data Sharing Agreement Annex, since the involvement of personal data is not envisaged for any of the Research Data generated during the project; • Removed "Obligations" chapter (moved to the Research Data Policy); • Data Repository to publish Publication Data must be compatible with OpenAIRE; • Removed opt-out option for Research Users; • Added information about MetaRepo; • Updated glossary; • Updated Research Data Policy; • Changes in the text and layout.	Submitted
3	20/02/2023	I. Modolo M. Panighel G. Brandino R. Aversa	Re-submission after reviewer comment: • Detailed the approach to the GDPR regarding the personal data provided by users for the recognition of the authorship of the published datasets; • Added references to NFFA-Europe Research Data Policy.	Submitted

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ABBREVIATIONS AND ACRONYMS

NFFA-Europe	Nanoscience Foundries and Fine Analysis – Europe
NEP	Nanoscience Foundries and Fine Analysis – Europe|PILOT
DMP	Data Management Plan
FAIR	Findable, Accessible, Interoperable, Reusable
JA	Joint Activities
EOSC	European Open Science Cloud
WP	Work Package
ORD Pilot	Open Research Data Pilot

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1. INTRODUCTION

The present document, NFFA-Europe Pilot Data Management Plan (NEP-DMP), addresses the management of all the Research Data produced within the NEP project. This is done in compliance with EU legislation and rules. Its purpose is to define a common strategy related to the management of data throughout the entire project life cycle.

The treatment and sharing between Access Providers of Personal Data concerning Research Users are regulated by the Privacy Policy, available on the NFFA-Europe Portal at https://www.nffa.eu/apply/privacy, and the related Data Sharing Agreement between the Beneficiaries.

The NEP project aims at enhancing the Open Access to NFFA-Europe distributed European research infrastructure at the nanoscale, available for academic and industrial researchers, set up with the previous NFFA-Europe project. The wide spectrum of Instruments and Measurement Techniques available in Access Providers' Sites across all Europe are accessible to Registered Users after the submission and approval of a Proposal.

The majority of the Research Data produced within NEP are created by Research Users during User Access to NFFA-Europe Infrastructure and by researchers affiliated with a Beneficiary or Third Party within the Joint Activities (WPs 11 to 15) and while performing in-house research related to the NFFA-Europe PILOT project. These individuals are hereinafter referred to as *Recipients*.

For an overview of the obligations and responsibilities to which the Recipients are subjected in terms of data management, please refer to the Research Data Policy (Annex 3).

Readers can consider the NEP-DMP as a *living document*, which can and will be updated throughout the entire project lifecycle. In order to keep track of different versions, the version number of each NEP-DMP is always included in the administrative section above. All Beneficiaries will be notified when a new version of the NEP-DMP is released.

1.1. Purpose of this document

The objective of this document is to describe the Research Data generated and processed during the entire project lifecycle, and how they will be managed, curated and preserved inside and outside the project.

Moreover, this document will give indications to manage Research Data in a FAIR way. In compliance with rules and recommendations described in this deliverable, each Laboratory will provide a DMP (Lab-DMP) related to the management of their Research Data.

1.2. Supplementary tools and documents

This document is complemented by a list of other documents that provide information on the way data will be collected and managed within the NEP project:

Annex 1: Glossary containing the definitions needed to deal with data management and NEP procedures. The glossary has the aim of providing a common language with all terms clearly defined.

Annex 2: Proposal Metadata Schema, with all the metadata available for each Research Users' accepted Proposal, acquired centrally through the Proposal submission form on the NFFA-Europe portal.

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Annex 3: Research Data Policy document that articulates the responsibilities of the individuals involved in Research Data management within the entire life of the NEP project.

2. DATA SUMMARY

The NEP project will generate data - including associated Metadata - in a wide range of R&D activities, including those needed to validate the Results of the project that will be presented in Scientific Publications and those associated with reports and other documents.

The format of the data and associated Metadata collected during NEP activities will be mainly electronic and can be classified in two major categories as follows:

Project documentation and reports	
Purpose of the data collection/generation	Official documents, deliverables, milestones, meeting reports, statistics, Proposal review evaluations, and other documents. Project's documents are shared between the individual components of the various axes and work packages on a dedicated space on the NFFA Datashare platform. Permissions are managed in a granular way on individual folders and also on individual documents, to ensure an access to data consistent with the roles assigned within the NEP project.
Data formats / types	Open files formats, although some files could be in proprietary formats such as .docx, .xlsx, .pdf
Origin of the data	Project documentation is produced by technical/administrative and research people involved in the project.
Expected size of the data	Less than 500 GB
Data utility	This data is used to monitor the progress of the project, follow the Proposal approval process on the portal and for compliance with any legal, contractual and regulatory obligation in relation to the European Commission, auditors and corporate statutory and auditing bodies.

Research Data	
Purpose of the data collection/generation	Research Data are collected and generated for specific research activities. It has to be noted that Research Data are mainly acquired through the research Proposals approved by the infrastructure. There is also minimal Research Data acquired within the NEP Joint Activities (WP from 11 to 15).
Data formats / types	Due to the large variety of Instruments and Measurement Techniques available, various data formats will be used during

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	the course of the project. In any case, data will be converted to a file format that can be opened with an open-source (or at least free) multi-platform software allowing third parties to access, mine, exploit, reproduce and disseminate it — free of charge.
Origin of the data	Research Data will be collected by Recipients.
Expected size of the data	≈ 10-50 TB
Data utility	The data could be used for scientific research and further validation, peer reviews, reproducibility and education, in the spirit of FAIR Data.

Before the publication of any Research Data, the Heads of Laboratory that operate within NFFA-Europe infrastructure are bound to draft a DMP (Lab-DMP) related to the management of the Research Data produced during the project and update it whenever needed. In the case of Access Providers, the Lab-DMP will be drafted before welcoming the first Research User in the Laboratory[1]. The Lab-DMP must be drafted and updated whenever needed using an online tool, called Data Stewardship Wizard, made available to Beneficiaries and Third Parties at the link https://dsw.nffa.eu/[2].

The Lab-DMPs produced by every Laboratory will integrate and extend the NEP-DMP in the next versions of the document[3].

In case of discrepancy or disagreement between the DMPs, the NEP-DMP shall prevail[4].

3. FAIR DATA

As a project participating in the Open Research Data Pilot (ORD-Pilot) in Horizon 2020, NEP will work to make its Research Data Findable, Accessible, Interoperable, and Reusable (FAIR)[5].

Work Package 16, Implementing FAIR Data approach within NEP, is fully devoted to this challenging task and aims at consolidating what was achieved within NFFA-Europe and at further developing new tools and services to provide guidelines and procedures for a FAIR Data approach. This specific activity will strongly benefit from the suggestions and contributions of the EOSC experts within the executive and strategy committee (ESC) of NEP. This joint activity is actively working to provide data services and support to Recipients.

For each of the Proposals approved within the infrastructure, the objective of NEP is to provide Research Users and Access Providers with tools ensuring that the Research Data are managed in a FAIR by design way.

[1] NFFA-Europe Research Data Policy, art 5.1.1 and 5.1.2 https://www.nffa.eu/apply/data-policy
[2] NFFA-Europe Research Data Policy, art 5.1.3 https://www.nffa.eu/apply/data-policy
[3] NFFA-Europe Research Data Policy, art 5.1.4 https://www.nffa.eu/apply/data-policy
[4] NFFA-Europe Research Data Policy, art 5.1.5 https://www.nffa.eu/apply/data-policy
[5] The FAIR Guiding Principles for scientific data management and stewardship https://dx.doi.org/10.1038/sdata.2016.18

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Making data FAIR ensures they can be found, understood and reused by the creators as well as by others. A useful tool for researchers and providers is the FAIR Data checklist (https://doi.org/10.5281/zenodo.5111307).

General scheme of FAIR principles[6]:

Findable	• Persistent ID • Metadata online
Accessible	• Data online • Restrictions where needed
Interoperable	• Use standards, controlled vocabularies • Common (open) formats
Reusable	• Rich documentation • Clear usage licence

Every Recipient will have the possibility to choose whether to adopt tools provided by the project or to use their own tools and good practices that have to be compliant with the FAIR principles.

3.1. Making data findable, including provisions for Metadata

Recipients are bound to make Research Data needed to validate the Results presented in a Scientific Publication or appearing in it (Publication Data) identifiable and locatable by means of a persistent identifier (PID), such as a Digital Object Identifiers (DOI), depositing the data in an appropriate OpenAIRE (http://www.openaire.eu) compatible open access Data Repository of their choice. Recipients generating the Research Data are allowed to choose a discipline-specific Data Repository, an institutional one, or a multi-disciplinary open repository like Zenodo (https://zenodo.org)[7]. Thus, NFFA-Europe Pilot relies on external services as regards the supply of persistent identifiers to the generated datasets.

Metadata of deposited Publication Data will be released under a Creative Common Public Domain Licence (CC 0), Attribution International (CC-BY) or a licence with equivalent rights and will include at least the following[8]:

- Brief description, Date of deposit and Author(s) of the Dataset
- Funding: "Horizon 2020"
- Grant project name, acronym and number: "Nanoscience Foundries and Fine Analysis - Europe|PILOT, NEP, 101007417"
- Licensing terms: CC BY, CC0 or a licence with equivalent rights
- Proposal ID number (if applicable)
- PID
- PID of related Scientific Publications and other research outputs (if applicable);

To promote findability and reusability of Publication Data, Task 16.1 of JA6 on FAIR data foresees the realisation of the MetaRepo, a generic metadata repository and Metadata Schema registry which provides metadata versioning and, at later time, Data Provenance, metadata search and

[6] OpenAIRE - The FAIR principles https://www.openaire.eu/what-are-the-fair-principles
[7] NFFA-Europe Research Data Policy, art 5.2.4 https://www.nffa.eu/apply/data-policy
[8] NFFA-Europe Research Data Policy, art 5.2.8 https://www.nffa.eu/apply/data-policy

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visualisation. It enables Data Curators to register Metadata Schemas in one of the two supported formats: XML Schema Definition (XSD) or JSON Schema, and it allows Research Users to store Metadata Documents which are automatically validated at upload time against the corresponding registered Metadata Schema. A more detailed description of the MetaRepo deployment is provided in Deliverable 9.1.

The MetaRepo will be populated with Metadata Documents linked to scientific Datasets resulting from Transnational Access Experiments, as well as with administrative Metadata Documents regarding the related Proposal and the Research User information.

A standard set of Metadata for each Research Users' accepted Proposal, namely the Proposal Metadata Document, will be automatically mapped from the NEP central database and registered into the MetaRepo after an accepted Proposal is assigned to the Site(s) where the Measurements will be carried out. The Proposal Metadata Document contains the information acquired centrally through the Proposal submission form on the NFFA-Europe portal. The related Metadata Schema can be found in Annex 2 (*Proposal Metadata Schema*).

This will allow all the Research Data produced and made available within the NEP to be linked to the corresponding Proposal and to be accessible to the Team Members only (unless access lists are modified by the owners of the resources). Proposal metadata will not be made openly available unless the Research User decides to publish them via the MetaRepo.

We underline the fact that with more than 180 different Measurement Techniques over a wide spectrum of different scientific disciplines it is not possible to identify a unique and meaningful Metadata Schema to describe the Experiment parameters.

Metadata definition and acquisition associated with scientific Instruments and Measurement Techniques require a strong commitment and involvement of the research groups. NEP Beneficiaries and Third Parties generating Research Data are strongly recommended to use Electronic Laboratory Notebooks (ELNs), in order to facilitate good data management practices, data and documentation sharing among researchers, prove provenance and protect from data loss.

One of the main goals of WP16 is to provide guidance on the definition of procedures and associated Metadata to help Recipients to have full control of data provenance.

In particular, Task 16.3 within the JA6 (EPFL/CNR/eXact lab/KIT) will elaborate and implement FAIR-oriented procedures and recommendations to enforce data provenance in the NFFA scientific Experiment's workflow, from data creation to data usage. The set of procedures will be developed by taking into account needs coming from various communities within NEP. Close attention will be paid to identify and tailor existing Electronic Laboratory Notebooks (ELN) and Laboratory Information Management System (LIMS) solutions for describing Sample processing workflows and (semi-) automated Metadata recording during the Experiments as initial steps for implementing FAIR by design Datasets. KIT can provide support for provenance (e.g., versioning) of existing Metadata created using an already adopted schema and for its storage.

3.2. Making data openly accessible

In the NEP project, Publication Data will be made openly available as soon as possible and at the latest by the date the Scientific Publication is published[9], using an appropriate Data Repository[10], as stated at point 3.1.

[9] NFFA-Europe Research Data Policy, art 5.2.6 https://www.nffa.eu/apply/data-policy
[10] NFFA-Europe Research Data Policy, art 5.2.4 https://www.nffa.eu/apply/data-policy

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3.3. Making data interoperable

To make data interoperable, that is allowing data exchange and integration between researchers, Institutions, organisations, countries, etc, Publication Data produced in the NEP project will be in a file format that can be opened with an open-source (or at least free) multi-platform software, making possible for third parties to access, mine, exploit, reproduce and disseminate it - free of charge for any user[11]. Moreover, metadata will include information about tools and instruments needed to re-use or validate the data (e.g. specialised software or software code, algorithms and analysis protocols)[12]. NEP encourages the use of platform-independent and non-proprietary file formats, to ensure accessibility by others and long-term preservation, to make them reusable in the future.

To improve interoperability, Recipients are recommended to use standard and ratified Metadata Schemas to describe Research Data (Metadata Standards), such as those listed on the Research Data Alliance's Metadata Standards Directory (http://rd-alliance.github.io/metadata-directory), on the Digital Curation Center website (http://www.dcc.ac.uk/resources/metadata-standards) or on FAIRsharing.org (https://fairsharing.org/standards)[13].

One of the main objectives of NEP is the creation of an advanced system for data and Metadata management and the implementation of Metadata Schemas for some of the Measurement Techniques in the NEP catalogue for which a commonly accepted Metadata Standard is not available. These Metadata Schemas aim to be commonly accepted by the relevant scientific community.

The reference format we propose for the creation of the nomenclature, Vocabulary and the Metadata Schemas is NeXus (https://www.nexusformat.org), suitably enriched with new entries consistent with it, if necessary.

NeXus is an international standard for the storage and exchange of neutron, x-ray, and muon Experiment data, but can in principle be extended to other techniques. The structure of NeXus files is extremely flexible, allowing the storage of both simple data sets, such as a single data array and its axes, and highly complex data and their associated Metadata, such as Measurements on a multi-component Instrument or numerical simulations. NeXus is built on top of the container format HDF5 (Hierarchical Data Format 5), and adds domain-specific rules for organising data within HDF5 files in addition to a dictionary of well-defined domain-specific field names. The documentation of the NeXus format can be found at the following link: https://manual.nexusformat.org/ref_doc.html.

The Metadata Schemas to be implemented should be able to describe, with a standardised structure and standard parameters, Datasets obtained from various types of Experiments, with the objective of becoming a standard. A minimum set of mandatory and recommended parameters will be accompanied by a dictionary containing the largest set of Metadata that may be needed depending on the Experiment and the Instrumentation used, to be added as needed.

Providers and experts involved in NEP are invited to cooperate and to submit their suggestions, any Metadata Standards already in use for their Instrument and their ideas for new ones.

New professional figures, defined as Data Curators or Data Stewards, will be trained and will act as a reference point for the curation and management of data within the NEP project. They will be in

[11] NFFA-Europe Research Data Policy, art 5.2.3 https://www.nffa.eu/apply/data-policy
[12] NFFA-Europe Research Data Policy, art 5.2.2 https://www.nffa.eu/apply/data-policy
[13] NFFA-Europe Research Data Policy, art 5.1.8 https://www.nffa.eu/apply/data-policy

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charge of reviewing, enhancing, cleaning, or standardising Metadata and the associated data, ensuring the FAIRness of the data.

3.4. Increase data re-use (through clarifying licences)

To allow for the widest possible reuse, all Publication Data will be published using the latest available version of the Creative Commons Attribution International Public Licence (CC BY) or Creative Commons Public Domain Dedication (CC 0) or a licence with equivalent rights[14].

In accordance with the FAIR guidelines, the intent is that the Research Data generated within the infrastructure can be reusable even after the end of the project, if allowed, and supported by the project resources and the necessary infrastructure. The exact length of time the data will remain reusable will be defined at a later stage.

4. Allocation of resources

Costs for repository development, infrastructure and curation will be covered by EC funding within the timeframe of the project and imputed to a specific Work Package (WP16).

Furthermore, CNR-IOM, the coordinator of the project, signed an agreement with Area Science Park in order to host all data services and data infrastructures available to NEP within ORFEO, the AREA Science Park data centre.

Resources for long term preservation have not yet been discussed, as this involves the general progress of the project and will be addressed in further versions of NEP-DMP.

5. Data security

NEP offers all Recipients and all Registered Users NFFA Datashare (https://datashare.nffa.eu), a file sharing and collaboration platform hosted on Italian servers managed by the project Beneficiary eXact lab. Although its use is not mandatory, the Consortium recommends its use to all Beneficiaries and Third Parties, especially if the facilities offering transnational access are not equipped with a secure and efficient cloud storage and sharing system. This instrument offers a secure tool for data storage and retrieval and gives the possibility to access, process and share scientific data, collaborating in real time with other team members. Therefore, team members will not carry data with them (e.g. on laptops, USB sticks, or other external media).

Authentication to the data management tools used in the project (NFFA Datashare, Data Stewardship Wizard and MetaRepo) are managed by the single sign-on system and stored exclusively in the Identity Provider database (Keycloak), while only an anonymous identifier is propagated. The MetaRepo collects monitoring data (ID of the authenticated user and the ID of the service) in order to send them to the NEP backend, without storing them locally.

All data centres where project data are stored carry sufficient certifications. All project web services are addressed via secure Hypertext Transfer Protocol (https). Any personal data contained in the Metadata Documents stored in the MetaRepo are neither checked or analysed, and are under the responsibility of the creator of the resource. Metadata Documents registered on the MetaRepo are stored on servers of NEP partner Karlsruher Institut für Technologie, which offer the necessary cyber security standards to guarantee protection from possible data leaks.

[14] NFFA-Europe Research Data Policy, art 5.2.7 https://www.nffa.eu/apply/data-policy

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The archive will be backed up both on-site and off-site to protect the data against disasters. The archive is protected against loss or theft. An access control policy is implemented to provide physical access to the archive. Personal data will be protected from unauthorised access, corruption, or theft throughout the entire project's lifecycle.

6. ETHICAL ASPECTS

Research Data generated by Research Users and by research staff within the NFFA-Europe PILOT project do not include questionnaires dealing with personal data nor do they raise ethical questions for their sharing to the scientific community.

All personal data collected for the execution of NEP services comply with the principles of purpose limitation, data minimisation, accuracy, storage limitation, integrity and confidentiality.

In the Proposal Metadata Document -the set of metadata mapped automatically by the NEP central database and registered in the MetaRepo after an accepted proposal is assigned to the access provider(s)- there are some non-sensitive personal data of the members of the proposing research team, i.e. : user ID, email, first name, last name, affiliation, country, role of the research user in the proposal. This personal data is information deemed useful for the description of the datasets produced within the project and for their authorship, but are initially accessible only to the members of the proposal team and can be published only upon explicit action by the user on the MetaRepo.

Furthermore, among the metadata describing the datasets generated within the research institutes, there may be non-sensitive personal data of the author, for the purpose of recognizing the authorship and correct citation and recognition of the research work. We suggest that participating institutions use metadata formats that contain the minimum of personal data necessary to acknowledge the authorship of the dataset, but we do not have full control over the practices of each laboratory. The formats supported in NEP are NeXus and JSON, and the personal data we recommend collecting is: name, role, affiliation, email and ORCID.

This personal data is deliberately provided by the researcher who generates the research data, who can upload the Metadata Document on the MetaRepo, managing its accessibility (private or public).

The handling of personal data is regulated by the Privacy Policy (https://www.nffa.eu/apply/privacy) and the Data Sharing Agreement accepted by all Beneficiaries and Third Parties, which governs the Joint Controllerships. All personal data are retained with the scope of delivering the service and the project follows the Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 – general data protection regulation (GDPR).

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ANNEX 1: GLOSSARY

In conjunction with the submission of the first version of the project DMP (D1.1), an extensive glossary was produced with the aim of standardising the terms used in the context of the NFFA-Europe Infrastructure.

Its content is constantly being updated and it is reachable online at https://www.nffa.eu/apply/data-policy/glossary

Here are definitions of the main terms used in this document:

Access Provider: a Beneficiary or linked Third Party that is in charge of providing access to one or more research infrastructures or Installations, or part of them.

Additional Data: any other data that is not Publication Data but is directly related to it as specified in the Data Management Plan (for instance curated data not directly attributable to a publication, or related Raw Data).

Analysed Data: identifiable Research Data which is a result of Raw Data processing obtained with the use of Data Analysis Software, typically after the end of an Experiment. It is typically a data file but it can be potentially a data stream, or other form of data relevant in a particular data management context. Analysed Data is stored in a Data Repository which may be the same as Raw Data. Analysed Data can be a part of a Dataset which may bear some semantics of what the data is and the origin/provenance of it.

Beneficiary: legal entity that signs the Grant Agreement with the European Union, represented by the European Commission, and which therefore undertakes to complete the actions envisaged in the funded project within the terms (temporal and legal) provided for in the Agreement.

Data Analysis: the identifiable action of processing Raw or Analysed Data. The analysis may be performed using Data Analysis Software and may be combined in chains or workflows. Data Analysis includes data processing and data interpretation.

Data Curator: person tasked with reviewing, enhancing, cleaning, or standardising Metadata and the associated data submitted for storage, use, and maintenance within a data centre or repository (ref. DataCite). A Data Curator is an expert on the management and oversight of an organisation's entire data to ensure compliance with policy and/or regulatory obligations for long term preservation and to provide higher-level users with high quality data that is easily accessible in a consistent manner. A Data Curator could collect and publish data using domain-specific standard formats, ensuring the FAIRness of the data.

Data Management Plan (DMP): a formal document that outlines what to do with data during and after a research project. It describes the type of data that will be used for research, how this data is collected, organised, and stored, and in which formats. It details how data will be accessible and documented for sharing and reuse during and after the project is finished.

Data Repository: an operational information system for managing and organising digital resources, particularly suitable for Datasets or Publication Data which are not likely to be altered again. The Data Repository contains Metadata about the Datasets, as well as given rules for data

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access. A Data Repository may be associated with a certain Institution or a group of them, or a certain Instrument or a group of them, or may be run by a third-party. A Data Repository may or may not be directly used by Research Users.

Dataset: collection of scientifically related Research Data which can be Raw Data , Analysed Data, or other Datasets, each described by their related Metadata. The components of a Dataset remain individually identifiable within the Dataset.

Electronic Laboratory Notebook (ELN): computer program designed to replace paper Laboratory notebooks. It is used by Instruments Scientist and Research Users to document research, procedures, and workflow performed during an Experiment and typically related to a particular Instrument.

Equipment: any scientific tool, device or machine used in the course of an Experiment.

Experiment: identifiable activity with a clear start time and finish time conducted by a Research User who uses one or more Instruments to investigate or produce one or more Samples and collects Raw Data about it. Experiment consists of (or includes – in case of Sample Preparation) one or a series of Measurements. Experiments can be a computer simulation (computational Experiment), or a combination of it with physical Measurements.

FAIR Data: data which meet the FAIR principles of findability, accessibility, interoperability, and reusability. The FAIR principles emphasise machine-actionability, i.e. the capacity of computational systems to find, access, interoperate, and reuse data with none or minimal human intervention.

Head of Laboratory: person who has the overall responsibility of technical, scientific and administrative operations of the laboratory/research group. She/He is responsible for assuring that the laboratory complies with EU obligations and regulations concerning research data. In accordance with these, will be in charge of drafting and regularly updating the DMP related to the management of the Research Data for the respective Laboratory or research group. This person is usually someone that is experienced with one or (possibly) more of the techniques offered, and should have a clear knowledge of the data produced and how this data is handled during the research process. Each Laboratory may have one or more Head of Laboratories.

Instrument: identifiable Equipment that allows performing a Measurement, and generates Raw Data during an Experiment. An instrument is located in a Laboratory hosted by an Institution and used by one or more Instrument Scientists or Research Users. Instrument can be a software for computer simulation (a software module or/and a particular configuration of it).

Laboratory: place where one or more Instruments for Research Users are operated and the Measurement is performed (could also be virtual). For computer simulation, a Laboratory may include hardware or/and software platform or/and services that allow to order and manage computational experiments, so that the software platform serves the purpose of managing software modules that can be considered virtual Instruments. Examples: a laboratory, a beamline, a cleanroom, etc.

Laboratory Information Management System (LIMS): software-based solution with features supporting Laboratory's operations, including - but not limited to - workflow and data tracking

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support, Sample management, Instrument integration (adapted from https://en.wikipedia.org/wiki/Laboratory_information_management_system).

Licence: official permission or permit to do, use, or own something (as well as the document of that permission or permit)

Measurement: the act of generating Raw Data for a Sample or a set of Samples during an Experiment using a particular Instrument under constant or varying controlled conditions, depending on the particular research context. Measurement is specific to Instrument: a research on the same Sample using a different Instrument implies a separate Measurement. Measurement can be a computer simulation, e.g. a particular run of a program using a particular model, configuration or input(s).

Metadata: set of descriptive, structural and contextual information describing the context, content and structure of Research Data and/or Datasets and their management through time. It describes information pertaining to research projects, including (but not limited to) the context of the Experiment, the Research Users, the Data Analysis methods, and other logistical information. Metadata may include descriptions of how data and files are named, physically structured, and stored.

Metadata Document: the actual document, written in JSON or XML format, containing the Metadata, following a Metadata Schema.

Metadata Schema: a logical plan showing the relationships between Metadata, normally through establishing rules for the use and management of Metadata specifically as regards the semantics, the syntax and the cardinality (mandatory, optional, recommended) of values. It can be written, e.g., in XSD (XML Schema Definition) or in JSON format, and may be implemented as machine actionable through consistent data entries and the inclusion of access points using controlled vocabularies. A Metadata Schema that gains wide acceptance from a reference user community and has been formally approved by Standards organisations, becomes a Metadata Standard.

Metadata Standard: a Metadata Schema that fulfils the needs of a scientific community, has obtained consensus, and has been ratified as a standard by some official bodies, such as the National Institute of Standards and Technology (NIST), the Dublin Core Metadata Initiative or the NeXus Data Format. A Metadata Standard describes the information and the terms needed to properly define specific data and it favours interoperability. In the NeXus Data Format, a Metadata Standard is called "Application Definition".

Open Access (OA): practice of providing online access to scientific information that is free of charge to the end-user and reusable. 'Scientific' refers to all academic disciplines. In the context of research and innovation, 'scientific information' can mean: peer-reviewed scientific research articles (published in scholarly journals), or Research Data (data underlying publications, curated data and/or Raw Data). Open Access is granted by providing a suitable open Licence such as Creative Commons Licences (CC BY or CC0).

Open Format: open standard which specifies a file format. An Open Format is a file format for storing digital data, defined by a published specification, usually maintained by a standards organisation, and which can be used and implemented by anyone. Open Formats are also called

free file formats if they are not encumbered by any copyrights, patents, trademarks or other restrictions so that anyone may use the format at no monetary cost for any desired purpose.

Persistent Identifier (PID): long-lasting, actionable reference to a Research Digital Object.

Proposal: application of one (usually the Team Leader) or more Registered Users to get User Access in order to perform one or more activities, in one or more Laboratories using one or more Instruments for taking one or more Measurements of one or more Samples during one or more Experiments. Instrument, Measurement, Experiment and Sample can refer to computer simulation environments.

Publication Data: Dataset(s) generated in the NFFA-Europe PILOT project needed to validate the Results presented in a Scientific Publication or appearing in it. Publication Data includes Raw Data, Analysed Data and all the relevant Metadata on Measurement and Data Analysis to validate them.

Raw Data: Research Data which is the primary output of a Measurement, generated by a particular Instrument and collected during an Experiment by a Research User or Instrument Scientist, before any subsequent processing. Raw Data is typically in the form of a data file but it can be potentially a data stream, or other form of data relevant in a particular data management context. Raw Data is stored in a Data Repository which may be the same as Analysed Data. Raw Data can be a result of a computer Experiment (simulation). Raw Data can be a part of a Dataset.

Recipient: Research User or researcher affiliated with a Beneficiary or a Third Party who performs activities related to the NFFA-Europe PILOT project.

Research Data: information (particularly facts or numbers) collected to be examined and considered and to serve as a basis for reasoning, discussion, or calculation in a research context. Examples of Research Data include statistics, results of Experiments, Measurements, observations resulting from fieldwork, survey results, interview recordings and images. Raw Data and Analysed Data are particular types of Research Data.

Research Data Policy: an identifiable expression of rules and regulations and sharing within NFFA-Europe PILOT project. Data Policy may be applicable to Publication Data, Raw Data or/and Analysed Data.

Research User: person who, after the approval of a Proposal, conducts an Experiment on one or more Laboratories using one or more Instruments in order to collect and analyse Research Data, or is interested in data collected or analysed by other Research Users on the same or other Laboratories. Research Users may be assigned with a role, e.g. Team Leader and Team Members.

Result: any (tangible or intangible) output of the Project such as data, knowledge, or information — whatever its form or nature, whether it can be protected or not — that is generated in the NFFA-Europe PILOT project, as well as any rights attached to it, including intellectual property rights.

Sample: identifiable piece of material with distinctive properties (structural, chemical, dimensional and others), composed by one or more Sample Component(s), exposed to Instrument during Measurement within a defined period of time. Sample may stand for a model or configuration or data input (or any combination of these) in computer simulations.

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Scientific Publication: any of the following contributions, peer-reviewed or not: article in a scientific journal (and related supporting information), monograph, book or book chapter, conference proceedings and 'grey literature' (i.e. informally published material not having gone through a standard publishing process, e.g. reports and highlights).

Third Party: any legal entity that has not signed the Grant Agreement. If it is necessary to implement the Project, a Party may involve Third Parties as defined in Article 8 of the Grant Agreement.

TLNet Node: person representing one or more Institutions providing Transnational Access within NFFA-Europe.

Transnational Access (TA): free of charge access to the Institutions which are part of NFFA-Europe Infrastructure through the NEP proposal evaluation system. Transnational Access can be in-presence or remote and both academic and industrial users can apply. A contribution for reimbursement of travel, accommodation and subsistence costs can be granted to a maximum of two Team Members per accepted Proposal.

User Access (UA): research activity performed according to a Proposal after its approval and carried out within a defined period of time. User Access may include, all or in part, the Data Analysis following the Experiment. NEP User Access can be Transnational Access and/or Virtual Access.

Virtual Access (VA): free of charge access to e-infrastructure, namely: sophisticated computer services; online data analysis tools; powerful computers, networks, grids, repositories, and databases.

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ANNEX 2: PROPOSAL METADATA SCHEMA

Metadata describing the accepted Research User Proposal, automatically acquired from the database.

- "status":
  - "timestamp": Date and time of submission of the proposal. [required]
  - "User_sub": ID of the Research User who submitted the proposal. [required]
- "call": Number of NEP calls for proposals. [required]
- "title": Proposal title. [required]
- "scientific_domain": Proposal scientific domain. [required]
- "erc_sectors": Groupings of disciplines established by the European Research Council. Two ERC sectors required, in order of relevance. [required]
- "material_system": Chemical and/or physical and/or functional definitions/keywords of the system intended to be developed/investigated. [required]
- "application": What the system is used for and in which field. [required]
- "Keywords" [required]
- "abstract": Proposal abstract. [required]
- "state_of_art": Current knowledge about the studied matter through the analysis of similar or related published work. [required]
- "objectives": Objectives of the Proposal and possibly their relation to Horizon Europe missions. [required]
- "references": List of references to key articles and texts cited in the Proposal, and/or that may be relevant to its development. [required]
- "proposal_steps":
  - "id": Proposal step ID
  - "technique"
    - "sql_id": ID of the selected Measurement Technique. [required]
    - "name": Name of the selected Measurement Technique. [required]
    - "acronym": Acronym of the selected Measurement Technique. [required]
    - “is_nano_lab": Indicates whether the selected Measurement Technique is a laboratory. [required]
    - "is_large_scale_facility": Indicates whether the selected Measurement Technique is a Large-Scale Facility. [required]
    - "parent_installation":
      - "sql_id": SQL_ID of the Parent Installation. [required]
      - "name": Name of the Parent Installation. [required]
      - "acronym": Acronym of the Parent Installation. [required]
      - "_id": ID of the Parent Installation. [required]
  - "purpose": Purpose of the research step. Scientific goals intended to be achieved by accessing a given set-up/method and how it relates with previous/following steps. [required]
  - "process_plan": How the experiment will be conducted and the timeline of this step. [required]
  - "technical_specifications": Main technical specifications of the selected instrument/method that are needed to successfully accomplish the experiment. Any ancillary techniques (never considered as a separate research step). [required]
  - "sample_cycles": Total number of cycles. At least one cycle is mandatory. [required]
  - "sample_cycle_details":
    - "samples_number": Number of samples. [required]
    - "measures_number": Number of measures/processes (at different physical conditions). [required]
  - "equipment_description": Brief description of any proprietary equipment to check compatibility and safety issues. [required]

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- "gender_dimension": Indicates whether sex and/or gender analysis/differences could be relevant in the research content or methods and whether the research findings will affect males and females differently. [required]
- "notes": Additional information on the proposal.
- "team_members":
    - "user_sub": ID of the Research User. [required]
    - "email": Email of the Research User. [required]
    - "first_name": Name of the Research User. [required]
    - "last_name": Last name of the Research User. [required]
    - "affiliation": Affiliation of the Research User. [required]
    - "country": Country of the affiliated university/institute/company. [required]
    - "proposal_role": Role of the Research User in the proposal (Team Leader or Team Member). [required]
    - "is_ppp_or_industry_employee": Indicates whether the Research User is an employee of an industry or of a PPP (Public-Private Partnership). [required]
- "has_industry_involvement": Indicates if there is any kind of industry involvement in the Proposal. [required]
    - "industry_involvement": Description of the industry involvement in the Proposal.
    - "industry_involvement_type": Type of industrial collaboration in the project.
    - "industry_type": Type of industry involved.
- "samples":
    - "substance": Substance name. [required]
    - "physical_state": Physical state of the substance. [required]
    - "chemical_formula": Chemical formula of the substance.
    - "size_x": mm
    - "size_y": mm
    - "size_z": mm
    - "nano": Indicates whether the sample is a nanostructured material or nanoparticle, i.e. whether the material consists mainly of individual entities (constituent particles that are separable from larger parts) with at least one external dimension in the range 1-100 nm. [required]
        - "nano_morph_aspect_ratio": Morphology: Aspect Ratio.
        - "nano_morph_particle_distribution": Morphology: Particle Size Distribution (nm).
        - "nano_morph_specific_surface": Morphology: Specific Surface Area (m2/cm3).
        - "nano_material_surface_chem": Material: Surface Chemistry.
        - "nano_material_crystalline_phases": Material: Crystalline Phases.
        - "nano_material_density": Material: Density (kg/m3).
        - "nano_solution_zeta_potential": Properties in solution: Zeta Potential (mV).
        - "nano_solution_hydrophobicity": Properties in solution: Hydrophobicity.
        - "nano_solution_water_solubility": Properties in solution: Water Solubility.
    - "order"
    - "working_pressure": Pa
    - "volume": L [required]
    - "storage_pressure": Pa
- "has_related_programme": Indicates whether the access request is related to other open access program grants for complementary work on the same scientific topic. [required]
    - "related_programme": Open access program and location.
- "previous_work": List of references to key articles and texts on previous work in the field.
- "is_previous": Indicates whether the Proposal is a continuation of a previous one. [required]
    - "previous_proposal_id": ID of the previous proposal.
    - "continuation_description": Any information that can help identify the previous proposal.
- "_id": ID of the Proposal. [required]

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Annex 3: Research Data Policy

Online version: https://www.nffa.eu/apply/data-policy

1. General principles

1.1. The present Research Data Policy covers ownership, curation and access to Research Data and Metadata collected during Transnational Access activities, in-house research and Joint Activities within the NFFA-Europe PILOT project.

1.2. NFFA-Europe PILOT project participates in the Open Research Data Pilot (ORD Pilot) action on Open Access to Research Data, therefore supports the integrity, transparency and openness of research, in a timely and responsible manner.

1.3. The obligations of the NFFA-Europe PILOT project as a participant in the ORD Pilot are set out in Article 29.3 of the Grant Agreement.

1.4. The present document follows the Guidelines on Open Access to Scientific Publications and Research Data in Horizon 2020.

1.5. Open Access to Research Data refers to the practice of providing online access to Research Data that is free to the end user and reusable.

2. Purposes

2.1. This policy aims to ensure that Research Data generated in the NFFA-Europe PILOT project are managed and made accessible for use and reuse according to the Guidelines on Open Access to Scientific Publications and Research Data in Horizon 2020.

2.2. This policy aims to ensure the continued availability of data of lasting value for research, education, and for wider exploitation by individuals, governments, businesses or other organisations.

2.3. This policy aims to articulate the responsibilities of all Recipients to Research Data.

2.4. This policy aims to assist Research Users and all researchers affiliated with a Beneficiary or a Third Party who perform activities related to NFFA-Europe PILOT project to fulfil their responsibilities with respect to the storage and retention of Research Data and Metadata associated with, and arising from, their research activities in the NFFA-Europe PILOT project.

2.5. This policy aims to provide guidance on existing good practices for producing FAIR Data.

2.6. This policy aims to inform all the NFFA-Europe Recipients about the data management tools made available by NFFA-Europe.

3. Definitions

Beneficiary: legal entity part of NFFA-Europe research infrastructure that signed the Grant Agreement with the European Union, represented by the European Commission, and which therefore undertakes to complete the actions envisaged in the funded project within the terms (temporal and legal) provided for.

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Data Management Plan (DMP): a formal document that outlines what to do with data during and after a research project. It describes the type of data that will be used for research, how this data is collected, organised, and stored, and in which formats. It details how data will be accessible and documented for sharing and reuse during and after the project is finished.

Data Repository: an operational information system for managing and organising digital resources, particularly suitable for Datasets or Publication Data which are not likely to be altered again. The Data Repository contains Metadata about the Datasets, as well as given rules for data access. A Data Repository may be associated with a certain Institution or a group of them, or a certain Instrument or a group of them, or may be run by a third-party. Data Repositories may or may not be directly used by Research Users.

Head of Laboratory: person who has the overall responsibility of technical, scientific and administrative operations of the laboratory/research group. She/He is responsible for assuring that the laboratory complies with EU obligations and regulations concerning research data. This person is usually someone that is experienced with one or (possibly) more of the techniques offered, and should have a clear knowledge of the data produced and how this data is handled during the research process. Each Laboratory may have one or more Head of Laboratories.

Metadata: set of descriptive, structural and contextual information describing the context, content and structure of Research Data and/or Datasets and their management through time. It describes information pertaining to research projects, including (but not limited to) the context of the Experiment, the Research Users, the Data Analysis methods, and other logistical information. Metadata may include descriptions of how data and files are named, physically structured, and stored.

Metadata Standard: a Metadata Schema that fulfils the needs of a scientific community, has obtained consensus, and has been ratified as a standard by some official bodies, such as the National Institute of Standards and Technology (NIST), the Dublin Core Metadata Initiative or the NeXus Data Format. A Metadata Standard describes the information and the terms needed to properly define specific data and it favours interoperability.

Publication Data: Dataset(s) generated in the NFFA-Europe PILOT project needed to validate the results presented in a Scientific Publication or appearing in it. Publication Data include Raw Data, Analysed Data and all the relevant Metadata on Measurement and Data Analysis to validate them.

Recipient: Research User or researcher affiliated with a Beneficiary or a Third Party who performs activities related to the NFFA-Europe PILOT project.

Research Data: information (particularly facts or numbers) collected to be examined and considered and to serve as a basis for reasoning, discussion, or calculation in a research context. Examples of Research Data include statistics, results of Experiments, Measurements, observations resulting from fieldwork, survey results, interview recordings and images. Raw Data and Analysed Data are particular types of Research Data.

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Research User: person who, after the approval of a Proposal, conducts an Experiment on one or more Laboratories using one or more Instruments in order to collect and analyse Research Data, or is interested in data collected or analysed by other Research Users on the same or other Laboratories. A Research User may be assigned with a role, e.g. Team Leader and Team Members.

Result: any (tangible or intangible) output of the Project such as data, knowledge, or information — whatever its form or nature, whether it can be protected or not — that is generated in the NFFA-Europe PILOT project, as well as any rights attached to it, including intellectual property rights.

Scientific Publication: any of the following contributions, peer-reviewed or not: article in a scientific journal (and related supporting information), monograph, book or book chapter, conference proceedings and 'grey literature' (i.e. informally published material not having gone through a standard publishing process, e.g. reports and highlights).

Other terms used in this policy are defined in the glossary available at https://www.nffa.eu/apply/data-policy/glossary.

4. Coverage

4.1. This policy applies primarily to the Research Data generated in the NFFA-Europe PILOT project (Raw Data or Analysed Data), including associated Metadata, needed to validate the Results presented in a Scientific Publication or appearing in it. These are hereinafter referred to as *Publication Data*.

4.2. This policy applies to Research Data and Metadata collected and generated by Research Users during Transnational Access to NFFA-Europe research infrastructure.

4.3. This policy applies to Research Data and Metadata collected and generated by researchers affiliated with a Beneficiary or a Third Party within NFFA-Europe PILOT Joint Activities.

4.4. This policy applies to Research Data and Metadata collected and generated by researchers affiliated with a Beneficiary or a Third Party while performing in-house research related to the NFFA-Europe PILOT project.

5. Policy Statements

5.1. Data Management

5.1.1. Before the publication of any Research Data and/or before welcoming the first Research User in the Laboratory, each Head of Laboratory that operate within NFFA-Europe research infrastructure must draft a DMP (Lab-DMP) related to the management of the Research Data produced in the NFFA-Europe PILOT project.

5.1.2. The Heads of Laboratory must update the Lab-DMP whenever needed.

5.1.3. The Lab-DMP must be drafted and updated using the Data Stewardship Wizard tool, available to Beneficiaries and Third Parties at https://dsw.nffa.eu.

5.1.4. The Lab-DMPs of every Laboratory integrate and extend the general NFFA-Europe PILOT Data Management Plan (NEP-DMP).

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5.1.5. In case of discrepancy or disagreement between the Lab-DMP and the NEP-DMP, the NEP-DMP shall prevail.

5.1.6. The Lab-DMPs of the Laboratories will be made available to Research Users at https://www.nffa.eu/about/data-management/data-management-plan/.

5.1.7. Recipients are strongly recommended to use Electronic Laboratory Notebooks (ELNs) if the Institution provides one, in order to facilitate good data management practices, data and documentation sharing among researchers, prove provenance and protect from data loss.

5.1.8. Recipients are recommended to describe accurately and completely the Research Data generated in the project intended to become part of a Scientific Publication, specifically considering functionality such as data findability, interoperability and reusability. If existing, the use of a formal Metadata Standard is recommended. An overview of existing Metadata Standards organised by discipline can be found on the Research Data Alliance's Metadata Standards Directory (http://rd-alliance.github.io/metadata-directory), on the Digital Curation Center website (http://www.dcc.ac.uk/resources/metadata-standards) or on FAIRsharing.org (https://fairsharing.org/standards). NFFA-Europe recommends using NeXus format or the general DataCite and Dublin Core Metadata Standards. Where no appropriate and formal Metadata Standard exists, writing "readme" style metadata is an appropriate strategy.

5.1.9. Recipients are recommended to store and backup all the Research Data generated in NFFA-Europe PILOT project in secure places, such as the NFFA Datashare platform (https://datashare.nffa.eu), a file sharing and collaboration platform hosted on servers under NFFA custody.

5.1.10. Research Users are invited to take advantage of the platforms and data and metadata management tools made available by NFFA-Europe PILOT project.

5.2. Access to Research Data and Metadata

5.2.1. Recipients must examine the possibility of protecting their Results in case these are reasonably expected to be commercially or industrially exploited (article 27 of the Grant Agreement).

5.2.2. Recipients must consider "Publication Data" any Research Data generated in the project (Raw Data and/or Analysed Data), including associated Metadata, needed to validate the Results presented in a Scientific Publication or appearing in it; Metadata has to include information about any other tools and instruments needed to re-use or validate the data (e.g. specialised software or software code, algorithms and analysis protocols).

5.2.3. Recipients must convert, if needed, the Publication Data to a file format that can be opened with an open-source — or at least free — multi-platform software and make it possible for third parties to access, mine, exploit, reproduce and disseminate it free of charge.

5.2.4. Recipients must choose an appropriate OpenAIRE compatible Data Repository to deposit Publication Data. It can be a discipline-specific Data Repository, an institutional one, or a multi-disciplinary open repository like

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Zenodo (https://zenodo.org/). Data Repositories compatible with OpenAIRE can be browsed here: https://explore.openaire.eu/search/content-providers.

5.2.5. As soon as possible and at the latest by the date the Scientific Publication is published, Recipients must deposit the Publication Data in the chosen Data repository.

5.2.6. At the latest by the date the Scientific Publication is published, Recipients must ensure Open Access to Publication Data via the Data Repository.

5.2.7. Publication Data must be published using the latest available version of the Creative Commons Attribution International Public Licence (CC BY) or Creative Commons Public Domain Dedication (CC 0) or a licence with equivalent rights.

5.2.8. Recipients must identify the deposited data by indicating in the deposition at least the following descriptive metadata:

- Brief description, Date of deposit and Author(s) of the Dataset
- Funding: "Horizon 2020"
- Grant project name, acronym and number: "Nanoscience Foundries and Fine Analysis - Europe|PILOT, NEP, 101007417"
- Licensing terms: CC BY, CC0 or a licence with equivalent rights
- Proposal ID number (if applicable)
- PID of related publications and other research outputs (if applicable).

5.2.9. Recipients are encouraged to provide - where possible - the tools and instruments needed to re-use or validate the data (e.g. specialised software or software code, algorithms and analysis protocols) - via the Data Repository or by other means.

5.2.10. Anybody reusing Publication Data must comply with the indicated licensing terms and are invited to cite the unique identifier as well as any Scientific Publications linked to the same Publication Data, if available and appropriate.

6. Roles and responsibilities

6.1. NFFA-Europe research infrastructure is responsible for providing appropriate support, advice and guidelines for the management of Research Data and the drafting of Lab-DMPs (see 5.1.1).

6.2. NFFA-Europe research infrastructure is responsible for disseminating this policy and notifying all Recipients when a new version is released.

6.3. NFFA-Europe research infrastructure is the custodian of all the Research Data and Metadata stored in the platforms and tools made available by the project and used in the services offered as Virtual Access.

6.4. The Heads of Laboratory of each Institution have the responsibility to ensure that the Lab-DMP is drafted, updated and adhered to throughout the project lifecycle.

6.5. Recipients have the responsibility to ensure that Research Data management and Open Access requirements described in chapter 5 of this policy are observed during and after the end of their research proposal.

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6.6. Each Institution part of NFFA-Europe research infrastructure is the custodian of the Research Data and Metadata generated by facility-maintained systems during NFFA-Europe-funded Experiments.

6.7. Acceptance of this policy is a condition for the award of NFFA-Europe Transnational Access services.

6.8. Deliberate infringements of this policy may lead to denial of access to Research Data and Metadata, and/or denial of future access to the NFFA-Europe research infrastructure.

6.9. NFFA-Europe research infrastructure is responsible for a long-term period of ten years to maintain Research Data and Metadata within the platforms and tools made available by the project. The actual retention period will depend on the type and volume of data and the economic consequences associated with long-term data storage. Thus, NFFA-Europe reserves the right to reduce the retention period in consultation with the respective Beneficiaries in charge of it.

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