ACTNXT

Advanced Characterization of
Technical components for
New Power-to-X Technologies

DMP - Data Management Plan
Deliverable D1.2

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Executive Summary

This deliverable addresses the data summary and relevant aspects of making data FAIR – findable, accessible, interoperable and reusable, including what data the ACTNXT project will collect and generate, whether and how it will be made accessible for verification and reuse, and how it will be curated and preserved. The ACTNXT project will collect raw data that will be further processed and generate model output. These data constitute the main research datasets that will be made available, some publicly and the sensitive data will be shared within the Consortium only.
This deliverable informs the available data to date, to whom the data is accessible and where to find the data. This helps the re-usability of data for other related EU projects' research and implementation. The ACTNXT project partners are the direct audience and beneficiaries of the Data Management Plan (DMP). However, depending on the accessibility of data collected, this DMP is useful for other researchers and practitioners beyond ACTNXT, as it indicates the type of data needed to be collected/generated to monitor and then evaluate the data.
This is a live document to be periodically elaborated and updated as the implementation of the project progresses. D1.2 is submitted in M6. There will be two follow-up versions of this initial DMP, the D1.4, DMP update due in M24 and D1.4, the DMP final at M48.

1. Introduction

The ACTNXT project aims to transform the European Research Infrastructure (RI) landscape to optimally support the development of Power-to-X (PtX) technologies, crucial for reaching net-zero emissions in line with the European Green Deal by 2050. By developing and deploying innovative scientific instrumentation and open experimental platforms, ACTNXT empowers both academic and industrial users, directly advancing the competitiveness and capacity of European RIs. This Data Management Plan (DMP), prepared by the Project Coordinator at DTI and approved by the Steering Committee at M6, ensures that ACTNXT research data supports these high-level objectives in full compliance with Horizon Europe requirements for FAIR and open data.
The DMP will be established by Month 6 and updated regularly as project needs evolve, guiding the responsible, secure, and open management of all data assets across the project lifecycle and beyond.

2. Data summary

This section describes the purpose and scope of data collection and generation in ACTNXT, directly aligned with the project's objectives. ACTNXT aims to strengthen the European Research Infrastructure (RI) landscape to support the development of Power-to-X (PtX) technologies. As such, the data generated serves both the development of innovative scientific instrumentation and the demonstration of its value to the Power-to-X scientific community, including broader societal and industrial stakeholders.

The main objectives of the data collected and generated within ACTNXT are:
- to enable advanced instrumentation development and support new PtX research activities at European RIs.
- to facilitate knowledge exchange and collaboration between partners, academia, industry, and the wider research community.
- to measure project progress and impact, supporting the achievement of the ACTNXT objectives and the European Green Deal goals.

2.1 Data Types

Data in ACTNXT originates from the project activities, including both technical and cross-cutting Work Packages. The main data types that will be collected at the RIs (ESRF, ILL, PSI, CERIC-ERIC, TUG, CU, at DTI and from the DEC activities are:

Experimental Data:
Raw and processed data from test benches and experiments at RIs, including operando neutron/synchrotron X-ray imaging, spectroscopy, and sensor data. These are typically numerical datasets (e.g., CSV, HDF5, including NeXus), multidimensional image files (TIFF, JPEG), and logs. CU generates raw and processed datasets from electrochemical tests, operando X-ray and neutron experiments, and materials characterization. Formats include CSV, HDF5, VMS, XY, TXT, XML, JPEG, and TIFF. CERIC-ERIC can offer over 60 instruments and therefore generates different types of data depending on which experiment is carried out. There are mostly text files, TIFF, JPEG files, log files and for synchrotron-related measurements they use mostly HDF5 files. TUG generates data in Hand CSV, TIFF and logs.

Instrument Metadata:
Automatically captured parameters and measurement conditions, integrated within RI digital infrastructures, to ensure full context and traceability (e.g., JSON, XML, HDF5, including NeXus). JSON is the most used at the RIs, especially for calibration and data processing.

Simulation Data:
Input scripts, outputs, and result files from simulation tools (such as McStas/McXtrace), shared in open the associated open formats (dat, py, instr, csv), supporting transparency and reproducibility. CU has both input and output from modelling tools (e.g., catalyst structure and transport simulations), often stored in DAT, PY, INSTR, CSV formats.TUG uses standard packages in dat and csv.

Data from existing data repositories:
ACTXNT Partners will use data generated from existing data repositories to conduct analyses, i.e. old beamtime application with a PtX theme.

Documentation and Workflows:
Standard operating procedures, user manuals, workflow descriptions, and project deliverables—variously in PDF, DOCX, TXT, Markdown, LaTeX. For Workflows, ESRF has its own system called EWOKS.

Software & Algorithms:
Open-source control, data reduction, and analysis code, primarily for innovative instrumentation, shared via established repositories (each RI has its own internal repository), typically in Python, C, in python scripts of jupyter sheets (ESRF) typically TXT, PY (CU).

Surveys and interviews:
Data from community engagement, requirements analysis, pre-characterization, and external stakeholder feedback, anonymised in line with regulations from the ACTNXT Consortium Agreement (ref. Section 2.3 on GDPR and protection of data).

Dissemination Materials:
Public deliverables, presentations, publications, and outreach material, stored as PDF, PPTX, and other common formats - accompanied by descriptive metadata.

Data Origin and Volume
Data originates from experiments at RIs, collaborative development activities within WPs, and from external partners' input. Due to the high-throughput nature of experimental data (especially imaging), the volume is expected to be significant, in the range of tens of terabytes per year.

Data Users and Reuse Potential
The primary data users are ACTNXT Project Partners, project-affiliated researchers and technicians at RIs, external academic and industrial PtX research community.
There are some data reuse possibilities such as experimental datasets, test bench workflows, and simulation tools, which are all reusable for validation, secondary analysis, follow-up experiments, and cross-infrastructure benchmarking, especially as all outputs are aligned with open science practices.

2.2 Data Use and Access

Internal use:
Data is primarily used by Project Partners to complete their technical work, assess instrumentation performance, validate results, and document project achievements. Confidential deliverables and

reports are accessible only to the consortium and the European Commission, securely stored on the consortium Teams platform and uploaded to the EU portal.

External Use:
Public deliverables and open data will be made available via the project website and open science repositories (such as Zenodo), supporting the scientific and industrial PtX community, as well as policy makers and the public. All external dissemination of confidential information requires explicit consortium approval, following the procedures in the Consortium Agreement.
Dissemination Practices:
Project results are published in open access, peer-reviewed journals, as well as presented at conferences and workshops. Non-scientific dissemination through interviews, public media, courses, and seminars will be pursued. All such actions involving confidential information are subject to consortium consent in accordance with the Consortium Agreement.

2.3 Confidentiality and Compliance

All data collection, storage, and dissemination activities in ACTNXT fully respects the rules set by the Consortium Agreement, including detailed provisions on data protection, confidentiality, and intellectual property. Public data is released under open licenses where possible; confidential and sensitive data is protected and only shared as agreed by the consortium or required by law.

Data Protection and GDPR
All Parties must cooperate to comply with all data protection laws applicable to their activities, especially the General Data Protection Regulation (EU) 2016/679 (GDPR), as well as any other relevant local laws ("Applicable Laws"). Where required by Applicable Laws or deemed desirable, the Partners will, before any data processing or sharing takes place, enter into separate agreements (e.g. data processing, data sharing, joint controller agreements) in good faith, to govern cross-partner personal data processing. The collection and handling of personal data (e.g. for event participation, surveys, community engagement) will always be managed under these agreements and in accordance with GDPR and the Consortium Agreement.

Dissemination and Confidentiality
All dissemination activities, including publications, presentations, and data sharing, must comply with the confidentiality provisions in Section 10 of the Consortium Agreement and cannot involve confidential information unless permitted in writing by the Disclosing Party.
Dissemination of own (including jointly owned) results by any Party is subject to advanced notice to the other Parties (min. 45 calendar days), with a 30-calendar day objection window. For posters and oral presentations, a reduced notice (15 calendar days) and objection period (10 calendar days) applies. No Partner may include another party's unpublished results or background in any dissemination activity without explicit prior written approval from the owning party. Cooperation and timely information exchange are required for thesis/dissertation publication, always subject to confidentiality and publication provisions. Use of Partner names, logos, or trademarks requires prior written approval, except for ACTNXT related communication and dissemination activities involving a "list of ACTXNT Project Partners". Nothing in the DMP or in the Project data confers advertising or publicity rights between Partners.

Confidential Information
All information marked as confidential or reasonably expected to be confidential by nature or circumstance must be protected for five years after the final payment has been received. Confidential data may only be used for project purposes, on a strict need-to-know basis, and must not be disclosed externally without written consent. If required by law, disclosure of confidential information must be

notified to the Disclosing Party before proceeding, to the extent legally possible. Upon project completion, confidential information (including copies and digital files) must be returned or securely destroyed, subject to compliance exceptions for legal obligations.
Partners must ensure their personnel, collaborators, and third parties are equally bound by these confidentiality obligations.

3. FAIR Data Principles

The FAIR Guiding Principles are developed in collaboration between stakeholders from academia, industry, funding agencies, and the publishers and serve as a framework to maximise both human and machine (online) findability and reusability of research data. ACTNXT fully follows these principles to ensure that the data generated contributes broadly to scientific progress in PtX research and instrumentation at European Research Infrastructures.

As ACTNXT is still at an early stage, it is not yet possible to determine which specific datasets or research outputs will have long-term value outside the project. Nevertheless, from the start the consortium is committed to making all potentially reusable datasets FAIR-compliant wherever practical, recognising both the scientific and societal benefits and enabling data sharing and re-use.
The sections that follow provide an overview of how ACTNXT will approach each aspect of the FAIR principles adapting their implementation to the types of data, workflows, and digital objects generated through project activities. While the FAIR principles do not define specific technical standards, they offer a framework for evaluating and optimising the management and utility of ACTNXT's research and digital assets. The consortium accepts that these principles should be followed pragmatically, applied in accordance with the context and requirements of each dataset or result. Accordingly, ACTNXT will also consider the applicability of FAIR not only to research data, but to other relevant digital data such as software, workflows, and documentation.

The following subsections describe ACTNXT's approach to each FAIR pillar.

3.1 Findable

Making data findable is a core focus from the outset. All datasets generated during the project will be continuously documented with rich, standardised metadata, drawing on the PaNOSC community profiles as well as widely accepted open standards such as Dublin Core and DataCite. This structured metadata will ensure that anyone, both within and outside the consortium, can easily identify and understand the context and contents of each data asset. In addition, persistent identifiers, such as Digital Object Identifiers (DOIs) or alternative handles, will be assigned to any dataset stored in community repositories like Zenodo or to institutional archives, guaranteeing long-term traceability and citability of ACTNXT results. To further support discoverability, an internal data catalogue will be maintained to document the existence and status of all data assets produced. Wherever possible, public metadata will be openly shared through external catalogues, enabling the broader research community to locate and request or access ACTNXT data when relevant.

3.2 Accessible

ACTNXT is committed to ensuring that, as far as possible, research data is made openly accessible with minimal barriers. All open data files such as publications or project deliverables will be deposited in trusted repositories such as Zenodo or other peer-reviewed journals already used by Project Partners These repositories are selected not only for their reliability and compliance with community standards, but also for their ability to facilitate persistent, stable access to digital research outputs.

Each open data entry will be linked directly to related publications or deliverables, thus ensuring full transparency and supporting reproducibility of results. Where data is classified as sensitive or confidential, access restrictions will be set in line with intellectual property rights, following the ACTNXT Consortium Agreement, and applicable ethical or legal frameworks. Even when data itself cannot be shared, metadata records will remain openly available, and a clear process will be published explaining how external parties may request access when permitted. Access procedures will always comply with both Consortium and facility-level data management policies, as well as with GDPR and other EU data governance requirements.

3.3 Interoperable

Because of the complex and multi-institutional nature of research carried out in ACTNXT, the Consortium will ensure interoperability of all generated data. Data will be stored in widely used, open file formats such as HDF5, CSV, TIFF, JSON, and NeXus for facility data, which promotes compatibility between systems and facilitates integration with community analysis tools. Wherever possible, the project will use controlled vocabularies, ontologies, and standard terminologies recommended by the PaNOSC project and the European Open Science Cloud (EOSC) communities to harmonise data description and categorisation. Comprehensive documentation will support all structured data, describing file formats, data structures, APIs, and software dependencies, to support seamless import, export, and re-use of data by collaborators, the broader research community, and enhance the automated systems.

3.4 Reusable

From the beginning, ACTNXT prioritises the reusability of data and software products as a means of amplifying project impact and promoting further innovation in PtX research. As a standard shared outputs will be clearly licensed for use, with open licences such as Creative Commons or the GNU Public License applied as appropriate. Adding detailed metadata and contextual documentation will be sufficient to make external re-use possible, including explanations of experimental design, methods, and workflows. This ensures that other researchers will have comprehensive information necessary to validate, replicate, or repurpose ACTNXT data in new contexts. Data underlying products such as publications and patented results will be provided as openly as possible, but will remain restricted where required for confidentiality or compliance reasons, always adhering to the principle of ‘as open as possible, as closed as necessary’. Furthermore, simulation, analysis, and workflow tools developed in the project will be distributed through collaborative code repositories, complete with version histories and strong issue tracking, ensuring their continued utility and improvement even after the project ends.

3.5 Data Security, Storage and Preservation

Data produced at RIs is governed by existing PaNOSC-compliant policies, making use of automatic metadata capture, secure storage infrastructure, regular backups, and long-term archiving at trusted facilities. Facility-based test benches will be integrated into these existing data management pipelines, ensuring seamless metadata capture and preservation. Data generated outside operational RIs (e.g., pre-characterization) will be securely archived by the originating partner using secure institutional servers. Preservation plans ensure that all research data, workflows, and code will remain available for at least 10 years after project conclusion, with transfer to long-term repositories where appropriate. Personal and sensitive data will be handled according to GDPR, encrypted, and access will be strictly limited to authorized personnel. Any personal data will be fully GDPR compliant and

retained only as long as necessary for the purposes of which it was collected. It will be deleted no longer than 5 years after project completion.

4. Open Science Commitment

The ACTNXT Consortium places open science at the core of its methodology. In fact, all research outputs, including publications, datasets, software, workflows, and test bench designs, will be made openly accessible whenever possible. Results and pre-prints will be shared via OpenAIRE-compliant portals and on the Open Research Europe platform. The project will promote early sharing of results, participation in open peer-review, and transparency of methods and negative results across all Work Packages. Simulation tools (McStas, McXtrace) will contribute to their open-source projects under established licences, and collaborative tools will be documented for external use. Confidentiality and IPR will be respected: data from industrial Partners or containing trade secrets will be handled with appropriate access controls, while anonymization procedures will be applied to human-centric data (interviews, surveys). Workshops, user meetings and training sessions will be open to the extent possible, with associated materials subsequently published under open access.

5. Roles and Responsibilities

The overall responsibility for research data management within ACTNXT lies with DTI, acting as project coordinator (WP 1). Each Project Partner will allocate the necessary resources to ensure the efficient and secure storage of data generated during the project, in full accordance with their own institutional policies, best practices, and regulatory obligations. Partners are encouraged to make use of their institutional repositories, which are available free of charge for this purpose.
To cover costs related to Article Processing Charges (APCs) for publication in open access journals, budget provisions have been made for each partner as outlined in the Grant Agreement (GA).

DTI provides a consortium-wide file-sharing system at no additional cost (Microsoft SharePoint). Data generated during the testing and measurements activities in the technical work packages (WP2, WP3, WP4, and WP5) will be acquired and stored in each RI internal data repository and server solution, with the precise location to be finalised based on technical and security requirements. Following each campaign, all relevant raw data will be backed up and centrally archived to ensure good long-term preservation and traceability. DTI will ensure that the platform remains secure, reliable, and up to date through regular maintenance and system updates, thereby safeguarding the integrity and availability of all project data throughout the duration of ACTNXT. This will be for project documents, presentations and minutes, not for technical and experimental data, which will be stored at each RI own repository.

6. Legal and Ethical Aspects

All data handling will comply with applicable EU and national regulations, with special focus on GDPR for personal data. Ethics requirements for human participant data and data sovereignty issues will be continuously addressed, backed by informed consent and impact assessments where needed. All policy documents, templates, and approval documents will be stored in the internal project documentation library.

The DMP is a living document and will evolve with project needs. New and emerging types of data, changing partner roles, or new technological developments will lead to DMP updates. Workshops and

user feedback will be used to refine data management practices to maximise scientific and societal benefit.

This DMP ensures ACTNXT achieves its vision for advancing the PtX research landscape, while setting a high standard for responsible, open, and FAIR-compliant research data management in line with European priorities.

7. Conclusion

The ACTNXT Data Management Plan establishes a comprehensive framework to ensure that all research data generated within the project is managed responsibly, securely, and in full compliance with the principles of FAIR, Open Science, and the data compliance & protection rules set out in the Consortium Agreement. By clearly defining data types, management procedures, access conditions, and legal responsibilities, including confidentiality, dissemination, and data protection, the DMP supports the project's ambition to advance PtX research and support a culture of collaboration and transparency. Ongoing monitoring and regular updates will ensure that the DMP remains a living document, responsive to new incoming data, or regulatory developments throughout the project's lifetime. Through this approach, the ACTNXT consortium is committed to maximising the scientific, societal, and industrial impact of its results, while safeguarding partner obligations and the rights of all stakeholders. This DMP thus strengthens the project's strategy and values and provides a foundation for achieving excellence in research data management within the ACTNXT and after the project ends.