NFDI 4 BIOIMAGE

National Research Data Infrastructure for Microscopy and Bioimage Analysis

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Public Progress Report Part 1 (B-1)

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Co-Applicant institutions

Heinrich Heine University Düsseldorf, German Cancer Research Center, European Molecular Biology Laboratory, University of Münster, Osnabrück University, Leibniz Institute for Natural Product Research and Infection Biology - Hans Knöll Institute, University of Konstanz, University of Leipzig, Leibniz Institute for Neurobiology, University of Freiburg, German BioImaging - Gesellschaft für Mikroskopie und Bildanalyse e.V.

Participating institutions

INP Greifswald, IPHT Leipzig, JGU Mainz, TU Dresden, HD University, MPIEB Plön, UFZ Leipzig, ISAS Dortmund, HAWK Hildesheim/Göttingen/Holzminden, University of Göttingen, University of Cologne, Forschungszentrum Jülich

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1 General Information

Name of the consortium:

NFDI4BIOIMAGE – National research data infrastructure for microscopy and bioimage analysis
NFDI4BIOIMAGE – Nationale Forschungsdateninfrastruktur für Mikroskopie und Bildanalyse

Research domains or research methods addressed by the consortium:

DFG Fachkollegien:
– 2.11 Basic Research in Biology and Medicine
– 2.12 Plant Sciences
– 2.13 Zoology
– 2.21 Microbiology, Virology & Immunology
– 2.23 Neurosciences
– 3.23 Optics, Quantum Optics and Physics of Atoms, Molecules and Plasmas
– 4.43 Computer Science

URL of the consortium website and repositories used for publishing output:

Description	Link
Website	https://nfdi4bioimage.de/
Zenodo Community	https://zenodo.org/communities/nfdi4bioimage
Proposal	https://doi.org/10.5281/zenodo.13168692
Community Forum	http://image.sc/tags/nfdi4bioimage
GitHub Organization	https://github.com/nfdi4bioimage
BioImage Archive	https://www.ebi.ac.uk/bioimage-archive/
Added-Value Database	https://idr.openmicroscopy.org/

2 Summary

Biological imaging is a core pillar of modern life science, enabling quantitative insight across scales and disciplines, from molecular biology to medicine. Increasingly, imaging is combined with other data modalities such as genomics and proteomics, positioning bioimaging at the heart of phenomics and integrative research. At the same time, bioimaging experiments are among the largest and most heterogeneous produced in academia, often surpassing terabyte scale. Without shared standards, scalable infrastructure, and coordinated community practices, much of this data risks remaining siloed or non-reusable, limiting its scientific value for the wider research community. NFDI4BIOIMAGE was established to address these challenges by embedding the German bioimaging community within a strong international ecosystem and contributing to long-standing global goals around data acquisition, management, discovery, and publication. Three years into its five-year funding period, NFDI4BIOIMAGE has become a visible and trusted actor in shaping how bioimaging data are standardized, shared, analyzed, and sustained, both nationally and internationally[1]. At its inception, the consortium defined four closely linked objectives, spanning the full bioimaging data lifecycle and aligning national efforts with international developments (Figure 1).

A central objective of NFDI4BIOIMAGE has been to champion **open, community-driven standards (Obj. 1)** that enable data to be reused across tools, institutions, and scientific domains. The consortium has led the development and international adoption of a Next-Generation File Format (NGFF) through a Request for Comments (RFC) process. This work directly addresses the needs of modern, cloud-scale, and multimodal imaging and has attracted sustained engagement from global partners, including follow-on funding from international sources such as Wellcome and Biohub. NGFF, however, goes beyond a file format, by enabling systematic extension in other ecosystems, like the emerging SpatialData standard for the specific needs of spatially resolved omics. This serves as a blueprint for domain-specific specialization from a shared core standard. In collaboration with the BioImage Archive (BIA) at EBI, the consortium is contributing to interoperable metadata specifications that move bioimaging closer to FAIR Digital Objects (FDOs), or *"FAIR Image Objects"* (FAIR-IO). Additional contributions include promotion of REMBI (Recommended Metadata for Biological Images) as a *de facto* metadata standard, RO-Crate–based packaging approaches, and expanding our data ambassador model into FAIR data champions who drive community adoption.

To make standards usable in practice, NFDI4BIOIMAGE has invested heavily in **scalable, interoperable infrastructure (Obj. 2)** supporting both national and international workflows. This includes cloud-ready analysis environments based on Jupyter, object storage, Desktop-as-a-Service (DaaS) and workflow platforms such as Galaxy, enabling reproducible analysis of large imaging datasets across infrastructures. The consortium has supported the migration of major international resources, including the Image Data Resource (IDR), to scalable cloud-based access models and has

[1] https://youtu.be/7nj2BkRJ8Q0

worked closely with EMBL-EBI to convert BioImage Archive holdings into REMBI-annotated NGFFs, namely OME-Zarr, substantially improving online accessibility and reuse.

At the software level, NFDI4BIOIMAGE has strengthened tools for **maximizing reproducible bioimage analysis (Obj. 3)**, such as Galaxy and JIPipe, adding features including RO-Crate packaging, OME-Zarr support, and OMERO integration to bridge experimental analysis pipelines with FAIR data publication. The BioImage ANalysis Desktop (BAND) has served as a key transitional DaaS platform, bringing users' experience closer to their large-scale imaging data in the cloud while maintaining an interactive, reproducible computational environment, which is particularly effective for training and lowering barriers to advanced analysis. The consortium has also engaged with emerging AI ecosystems like Hugging Face, aligning bioimaging workflows with broader developments in machine learning and reproducible research. In parallel, the consortium has supported local data stewardship and storage solutions at multiple German institutions and the operation of federated OMERO services, ensuring national capacity grows in step with international alignment.

A defining strength of NFDI4BIOIMAGE is its emphasis on **capacitating researchers through training and data stewardship (Obj. 4)**. Over the past three years, the consortium has delivered a broad program of training and capacity building, including institutional workshops, national courses, and contributing to major international conferences, and enhanced access to open educational resources for bioimaging RDM. Flagship initiatives such as RDM4mic and I3D:bio have significantly raised awareness and competence around research data management in bioimaging by giving the community a platform to actively engage. NFDI4BIOIMAGE has, furthermore, helped professionalize data stewardship roles through helpdesks and cross-consortia collaboration, supported data submission to the BioImage Archive, and improved discoverability through catalogs of tools, services, and use cases integrated into institutional research structures.

In addition, NFDI4BIOIMAGE contributes actively beyond its consortium. The speaker has chaired the NFDI *Konsortialversammlung* while members participate broadly in relevant NFDI Sections, notably those focused on metadata (including ontologies, search, and knowledge graphs) and on common infrastructure and data integration. Internationally, consortium members contribute to ISO standardization, provide leadership within the Open Microscopy Environment (OME), and represent bioimaging interests in the European Open Science Cloud (EOSC). Engagement in initiatives such as IO-FAST and foundingGIDE, together with close ties to Global BioImaging, further amplify Germany's visibility in the global imaging landscape. For the final two years of funding, NFDI4BIOIMAGE's priorities include the formal standardization of widely adopted practices for bioimage data, establishment of a national OMERO framework in coordination with de.NBI (underpinned by an MoU), and the development of sustainable operational models for bioimaging data services. While challenges remain, particularly around long-term sustainability and scaling, the consortium has laid a robust foundation. By combining standards, infrastructure, tools, and people, NFDI4BIOIMAGE has positioned Germany as a central contributor to a FAIR, reproducible, globally connected bioimaging ecosystem.

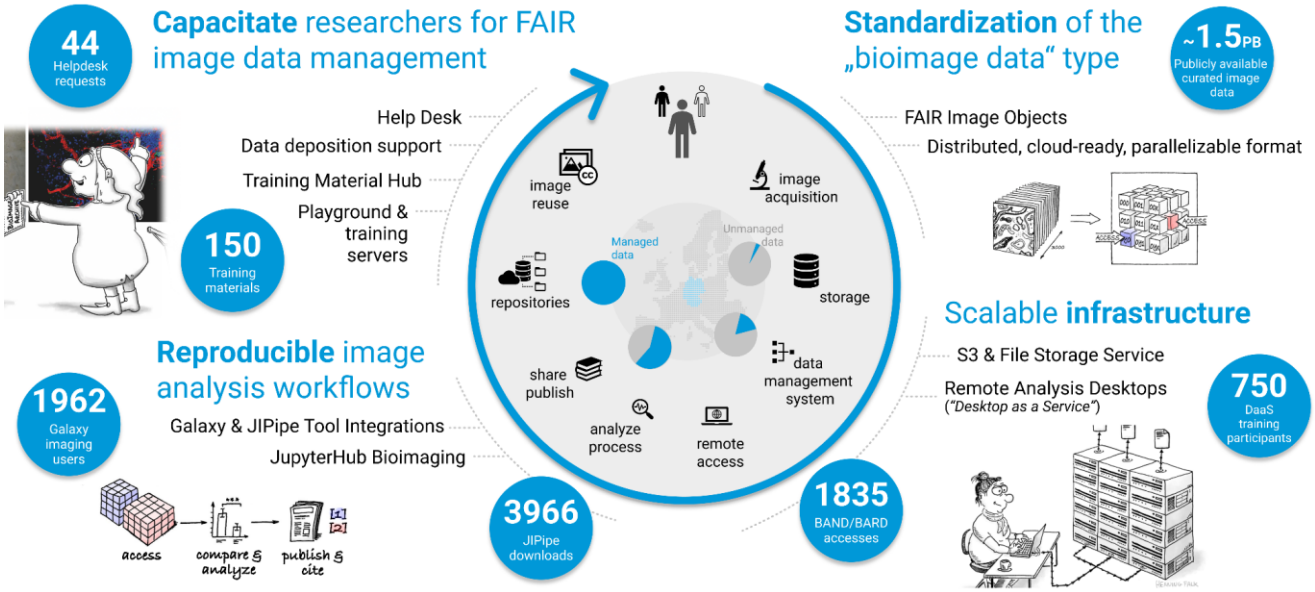

Figure 1: Services and selected achievements of NFDI4BIOIMAGE according to our four main objectives; cartoon images: "Monolithic vs. chunked", "Bea computes", and "FAIR re-use" by Henning Falk, ©2022 NumFOCUS, and "It's time to publish" by Henning Falk are used under a CC BY 4.0 license. Modifications to the drawings include cropping.

3 Composition of the consortium

- Applicant institution

Applicant institution	Location	Duration
Heinrich Heine University Düsseldorf (HHU) *Head:* Prof. Dr. Anja Steinbeck	Universitätsstraße 1 40225 Düsseldorf	03/23 - today

- Spokesperson

Spokesperson	Institution, location	Duration
Prof. Dr. Stefanie Weidtkamp-Peters	Heinrich Heine University, Düsseldorf	03/23 - today

- Co-applicant institutions

Co-applicant institutions	Location	Duration
German BioImaging - Gesellschaft für Mikroskopie und Bildanalyse e.V. (GerBI-GMB) *Chair*: Prof. Dr. Stefanie Weidtkamp-Peters	c/o University of Konstanz 78547 Konstanz	03/23 - today
University of Konstanz (UKON) *Head:* Prof. Dr. Katharina Holzinger	Universitätsstraße 10 78457 Konstanz	03/23 - today
German Cancer Research Center (DKFZ) *Head:* Prof. Dr. Michael Baumann	Im Neuenheimer Feld 280 69120 Heidelberg	03/23 - today
European Molecular Biology Laboratory (EMBL) *Interim Head*: Prof. Ewan Birney, Ph.D.	Meyerhofstr. 1 69117 Heidelberg	03/23 - today

Osnabrück University (UOS) *Head*: Prof. Dr. Susanne Menzel-Riedl	Neuer Graben 29 / Schloss 49074 Osnabrück	03/23 - today
Leibniz Institute for Neurobiology (LIN) *Head*: Prof. Dr. Stefan Remy	Brenneckerstr. 6 39118 Magdeburg	03/23 - today
Leibniz Institute for Natural Product Research and Infection Biology, Hans Knöll Institute (HKI) *Head*: Prof. Dr. Axel A. Brakhage	Beutenbergstr. 11a 07745 Jena	03/23 - today
Technische Universität Dresden (TUD) *Head*: Prof. Dr. Ursula M. Staudinger	01062 Dresden	03/23 - 12/23 now: Participant
University of Leipzig (UL), ScaDS.AI *Head*: Prof. Dr. Eva Inés Obergfell	Ritterstraße 26, 04109 Leipzig	01/24 - today
University of Münster (UM) *Head*: Prof. Dr. Johannes Wessels	Schlossplatz 2 48149 Münster	03/23 - today
University of Freiburg (ALU-FR) *Head*: Prof. Dr. Kerstin Krieglstein	Friedrichstraße 39 79098 Freiburg	03/23 - today

- Co-spokespersons

Co-spokespersons	Institution, location	Task area(s)	Duration
Prof. Dr. Stefanie Weidtkamp-Peters	German BioImaging – Society for Microscopy and Image Analysis e. V. (GerBI-GMB)	**TA1**, **TA6**	03/23 - today
Prof. Dr. Elisa May	German Cancer Research Center (DKFZ), Heidelberg & University of Konstanz (UKON), Konstanz	**TA6**, TA5	03/23 - today
Dr. Jan-Philipp Mallm	German Cancer Research Center (DKFZ), Heidelberg	**TA3**	03/23 - today
Dr. Anna Kreshuk	European Molecular Biology Laboratory (EMBL), Heidelberg	**TA4**	03/23 - today
Dr. Susanne Kunis	Osnabrück University (UOS), Osnabrück	**TA1**	03/23 - today
Prof. Dr. Marc Thilo Figge	Leibniz Institute for Natural Product Research and Infection Biology, Hans Knöll Institute (HKI), Jena	**TA4**	03/23 - today
Dr. Robert Haase	Data Science Center, Uni Leipzig ScaDS.AI Dresden / Leipzig	**TA5**, TA4	03/23 - today
Dr. Thomas Zobel	University of Münster (UM)	**TA5**	03/23 - today
Dr. Markus Blank-Burian	University of Münster (UM)	**TA2**	03/23 - today
Dr. Björn Grüning	Albert-Ludwigs-University of Freiburg (ALU-FR)	**TA2**	03/23 - today
Dr. Werner Zuschratter	Leibniz Institute for Neuroscience (LIN), Magdeburg	**TA3**	03/23 - 02/25
Prof. Dr. Stefan Remy	Leibniz Institute for Neuroscience (LIN), Magdeburg	**TA3**	02/25 - today

- Participants

Participating institutions	Location	Duration
Heidelberg University (UHD)	Heidelberg	03/23 - today
University of Cologne (UoC)	Köln	03/23 - today
Georg-August-University of Göttingen (UGOE)	Göttingen	03/23 - today
Technical University of Dortmund (TUDo)	Dortmund	03/23
Leibniz Institute for Plasma Science and Technology (INP)	Greifswald	03/23 - today
Helmholtz-Center for Environmental Research (UFZ)	Leipzig	03/23 - today
Leibniz Institute of Photonic Technology (IPHT)	Jena	03/23 - today
Leibniz Institute for Analytical Sciences (ISAS)	Dortmund	03/23 - today
Forschungszentrum Jülich (FZJ)	Jülich	03/23 - today
Max Planck Institute for Evolutionary Biology (MPIEB)	Plön	03/23 - today
Hochschule für Angew. Wissenschaft und Kunst (HAWK)	Göttingen	03/23 - today
Johannes Gutenberg Universität (JGU)	Mainz	03/23 - today
Technische Universität Dresden (TUD)	Dresden	01/24 - today (before: Co-applicant)

Participating individuals	Institution	Duration
Dr. Jean-Marie Burel, Open Microscopy Environment Consortium	University of Dundee, UK	03/23 - today

Disclaimer: The NFDI4BIOIMAGE project is a collaboration of co-applicant institutions and participating institutions. NFDI4BIOIMAGE is legally non-independent and does not engage in any external legal transactions. Within the framework of the collaboration, the project partners each work on subtasks in their own name.