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Helmholtz Open Science Briefing

Helmholtz Open Science Forum "Towards Open Digital Research Ecosystems – Interconnecting Infrastructures"

Report

Imprint

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Abstract

Digital infrastructures have become indispensable in the field of modern research and science. These technological frameworks play a crucial role for the entire research cycle, supporting literature searches, aiding in data collection and analysis, facilitating the creation and publication of scholarly works, and ensuring the thorough documentation and long-term storage of research findings. Additionally, these infrastructures serve as a vital means for networking and communication among peers, creating the essential foundation of an open and transparent science and research ecosystem.

Helmholtz employees were invited to join the Helmholtz Open Science Forum "Towards Open Digital Research Ecosystems - Interconnection Infrastructures" on February 14, 2024, where options for the seamless integration of these digital infrastructures have been discussed. Speakers presented insights into diverse efforts to the provision of open infrastructure structures and how their interconnection offers new possibilities for seamless and integrated workflows within the increasingly digitized research. Further, it was examined how such an integrated ecosystem can support open science practices and vice versa

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Introduction

The Helmholtz Open Science Forum on the topic of "Towards Open Digital Research Ecosystems - Interconnecting Infrastructures" on February 14, 2024 was organized by the Helmholtz Open Science Office.

Together with the speakers (table 1) and more than 50 participants, approaches and perspectives for the development of open digital research ecosystems were presented and discussed.

The Helmholtz Open Science Forum offers an opportunity for exchange, networking, and information. This virtual event also served to maintain and create awareness of the topic of research evaluation within the Helmholtz Association.

This report documents the event; the slides of the speakers can be found in the appendix of this report (from p. 9 onwards).

Table 1: Program of the Helmholtz Open Science Forum "Towards Open Digital Research Ecosystems - Interconnecting Infrastructures", February 14, 2024

Program	Speaker
Welcome	Roland Bertelmann, Helmholtz Open Science Office
Introduction	Wolfgang zu Castell, GFZ German Research Centre for Geosciences
Advanced Information and Publication Management	Robert Thiele, Deutsches Elektronen-Synchrotron DESY
Pioneering Digital Research Landscapes: Innovations at HZDR	Oliver Knodel, Helmholtz-Zentrum Dresden-Rossendorf HZDR
Information on LabInfrastructure@Geo.X	Manja Luzi-Helbing, GFZ German Research Centre for Geosciences, Geo.X
The Open Infrastructure Portal for DESY and HIFIS	Tim Wetzel, Deutsches Elektronen-Synchrotron DESY
Replicable image analysis across domains	Deborah Schmidt, Helmholtz Imaging, Max Delbrück Center MDC
The iDAI.world: an interconnected research infrastructures in an open science world	Fabian Riebschläger, German Archaeological Institut DAI
SciLake: the OpenAIRE Graph use-case	Paolo Manghi, OpenAIRE AMKE (Greece) and Institute of Information Science and Technologies, CNR (Italy)

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Documentation of the Forum

Introduction

Wolfgang zu Castell is heading the Department Geoinformation at the German Research Centre for Geosciences GFZ. Being chair of the Helmholtz Open Science Working Group, he has a broad expertise in various fields of open science. He further serves as member of the Steering Board of Helmholtz Imaging as well as of the Steering Board of the Helmholtz Metadata Collaboration.

In his talk he introduced the basic concept of Open Science. Since the research cycle is getting more and more digitized, there are increasing possibilities to take short cuts between the different stages of the research process and hook in on other steps while you are in the middle of the research process- in contrast to the learned linear following of the cycle. In doing so, he drew a line to the importance of open digital research ecosystems and possible perspectives regarding the establishment of infrastructures that allow these new ways of conducting research and how they can help to improve workflows and increase efficiency.

Open Access by DESY and the role of preprints[1]

Robert Thiele has been working as a subject librarian in the library of Deutsches Elektronen-Synchrotron DESY since 2013. Moreover, he heads the Publishing and Publications team at the DESY library and he is responsible for the DESY publication server PubDB. The comprehensive management of information on publications can often be challenging. Especially, when channels outside the usual ways of scientific communication, like the publication of preprints via dedicated preprint-servers or other formats come into play. Questions besides a comprehensive publication record arise, like the connection of different states of a manuscript via different platforms, workflows for approval of early-stage publications or reporting procedures. Still, thinking outside the box and using innovative publication channels offers chances to increase visibility of research and the share of openly available publications. The presentation gave insights in the advanced workflows and strategies at DESY to handle diverse kinds of publications throughout different systems and how these systems are brought together to form an advanced ecosystem around the management and processing of information and publication.

[1] The slides of this and all other presentations are attached to this document.

Pioneering Digital Research Landscapes: Innovations at HZDR

Oliver Knodel has been working at the Helmholtz-Zentrum Dresden - Rossendorf (HZDR) since 2018 and has been head of the "Data Management and HPC" working group since 2022. He presented the data management systems and services of the HZDR including an overview of a self-developed control system called HELIPORT.

When dealing with research data management, researchers at Helmholtz-Zentrum Dresden – Rossendorf (HZDR) face a variety of systems and tools. These range from the project planning phase (proposal management, data management plans and policies), over documentation during the experiment or simulation campaign, to the publication (collaborative authoring tools, metadata catalogs, publication systems, data repositories). In addition, modern research projects usually are required to interact with a variety of software stacks and workflow management systems to allow comprehensible and FAIR science on the underlying IT infrastructure (HPC, data storage, network file systems, archives). HELIPORT is HZDR's approach to address this variety of requirements and give its users a streamlined experience when dealing with those challenges.

LabInfrastructure@Geo.X – A Search Portal for Laboratory Infrastructure

Manja Luzi-Helbing is scientific consultant at the GFZ German Research Centre for Geosciences in the Executive Board group Synergies and Networks. She presented the LabInfrastructure@Geo.X - a search portal for the laboratory infrastructure in the Geo.X network. It provides information on instruments, analytical methods, contact persons, links to the laboratories' websites, and key and data publications. The knowledge of the network's laboratory infrastructure and its access options supports collaborations and joint projects. The portal includes over 220 entries from all nine Geo.X partner institutions and is continuously expanding.

As part of the Helmholtz DataHub initiative at GFZ, LabInfrastructure@Geo.X was developed as a service designed to enable role-based curation of information about the laboratory infrastructure, which can be made available in a search portal. LabInfrastructure@Geo.X is customized to the needs of the Geo.X network, but its concept is compatible with multiple institutional or network environments within Helmholtz and beyond.

LabInfrastructure@Geo.X is being integrated into the digital research ecosystem at GFZ cooperating with other services such as GFZ Data Services, the Sensor Management System and the HMC project ALAMEDA. It is also embedded into the NFDI4Earth landscape and supports the international initiative OneGeochemistry. In this context, parts of the vocabulary developed for LabInfrastructure@Geo.X were integrated into a common conceptual scheme for analysis methods in geochemistry and cosmochemistry which was published at Research Vocabularies Australia.

Technical key elements:

- Web-based user interface (change request form) for the submission of new or modified laboratory metadata. A controlled set of vocabulary derived from the NASA GCMD instrument keywords and a vocabulary adapted for the Geo.X network is used for keywording instruments and analysis methods.
- Management interface which facilitates decentralised editing and maintenance of the laboratory metadata
- Semantic search options and filter functions aligned with the needs of the scientific target groups.

The Open Infrastructure Portal for DESY and HIFIS

Tim Wetzel is a research associate at Deutsches Elektronen-Synchrotron DESY at the IT department. Since 2020 he is working on AAI, research data management and data transfers as well as cloud solutions for scientific web services. He presented a concept of the Open Infrastructure Portal for DESY and HIFIS.

The portal makes open data accessible to scientists and to the public. It will consist of three components that interface directly with each other. The data catalog "Scicat" is used to make data sets available including technical and scientific metadata as well as how to access them. The data sets themselves are stored on a "dCache" instance, a storage system that is widely used in the high-energy physics community. Upon reasonable request computing resources and storage access can be provided via DESY's VISA portal that allows data and compute access including pre-installed analysis tools via a graphical user interface in the browser.

The installation of this portal package is performed together with colleagues from DAPHNE4NFDI and will be a way to make data sets not only public but also FAIR.

Replicable image analysis across domains

Deborah Schmidt is head of the Helmholtz Imaging Support Unit at the Max Delbrück Center for Molecular Medicine in Berlin. She provided insights into the Helmholtz Imaging Support Unit.

Imagine a biologist trying to understand cell behavior by looking at organelle structures in 3D but running into issues with making the process reliable. At the same time, a materials scientist is trying to see the tiny details of metals and faces similar problems. How can they benefit from each other's learning processes? Helmholtz Imaging, bridging diverse scientific domains, leverages its unique position not only to identify common bottlenecks in the imaging pipeline but also to facilitate the exchange of solutions across fields. This presentation will explore the journey of Helmholtz Imaging Support scientists deploying user-friendly, accessible technologies and strategies that cater to the immediate needs of researchers across domains. Their experience reinforces the vital role of a supportive, adaptable framework, complementing the longer-term pursuit of cross-domain standards.

The iDAI.world: an interconnected research infrastructure in an open science world

Fabian Riebschläger is head of the Research Data Management department at the Central Scientific Services of the German Archaeological Institute (DAI). In his presentation, he introduces the digital integrated information system for ancient studies "iDAI.world". It is operated by the DAI, a globally interconnected research institution formally associated with the Federal Foreign Office and dedicated to archaeology and ancient history. The iDAI.world consists of a series of interconnected systems and functions as a digital research environment, offering tools and repositories to facilitate the collection, documentation, storage, analysis, visualization and publication of research data. Multilingualism and worldwide accessibility are underlying principles of iDAI.world

This presentation provided a general overview of iDAI.world. The emphasis was on the connection of the individual data records that are stored in independent databases of the respective systems through the use of standardized data and a very structured approach.

SciLake: Assisting domain-specific applications on top of open SKGs - The OpenAIRE Graph use-case

Paolo Manghi is the Chief Technology Officer of OpenAIRE AMKE and responsible for the OpenAIRE Graph. He is involved in coordination and/or research activities in EOSC-related projects and he presented the concept of SciLake.

SciLake builds upon the OpenAIRE ecosystem and EOSC services to enable creation, interlinking, and maintenance of Science Knowledge Graphs (SKGs) and execution of data science and graph mining queries on top of them unlock the vast scientific knowledge space with advanced, AI-based services that exploit customized perspectives. The OpenAIRE Graph is an SKG in support of Open Science publishing discovery and monitoring, used by researchers, organization, ministries, and funders for their scientific experiments, data analysis, impact and monitoring of investments. This presentation will present SciLake, its objectives, and the contribution to its activities, both as provider and consumer of data, of the OpenAIRE Graph.

Summary and Outlook

The event showed that there are manifold approaches to interconnect stand-alone silo-like infrastructures. This enables researchers, institutions or the society in general to link data and (meta-)information, find previously unknown connections between previously unconnected facts, find new and effective ways to manage digital workflows and thus optimize their work in administrative or research contexts.

The events have shown that these approaches can work with very different levels of complexity. It was made clear that some very basic requirements must be met for the successful implementation of such networked infrastructures.

To bring infrastructures together there is, for example, a need for persistent identifiers, which are a crucial element in many projects, as they enable the unique and permanent location of resources and enable knowledge graphs for structured and networked presentation of scientific information. Standardization through metadata and metadata schemas also plays a central role in linking information systems. In direct relation to this the use of common terminologies is needed to overcome information-silos. Ontologies can help here to make infrastructures speak the same language and enable them to get in exchange with each other to connect heterogenous artifacts of the same contexts. Furthermore, the urgent need to use open source systems was emphasized in order to be able to change and adapt the interfaces for the automatic exchange of information between the infrastructures. Moreover, it was emphasized that such systems - especially if they are made available to a wider public - require the necessary technical basis to be able to handle the tasks in different areas and at different scales. Against this background, suitable governance models must also be developed and applied. The importance of developments for European and international networking and interconnection was also underlined.

It became clear that there are many questions around open and interconnected infrastructures to be answered, but various Helmholtz Centers are developing specific approaches. Connecting platforms such as HIFIS or Helmholtz Imaging form a link and can support these developments. This forum marked a first step to discuss and coordinate respective efforts in Helmholtz and to bring people together. Further efforts are needed to connect people, approaches and ideas around this topic and to advance the idea of interconnected digital research ecosystems at Helmholtz and beyond.

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Appendix

Presentation Slides

- "Towards Open Digital Research Ecosystems" - Wolfgang zu Castell, GFZ German Research Centre for Geosciences
- "Open Access by DESY and the role of preprints" - Robert Thiele, Deutsches Elektronen-Synchrotron DESY
- "Pioneering Digital Research Landscapes: Innovations at HZDR" - Oliver Knodel, Helmholtz-Zentrum Dresden-Rossendorf HZDR
- LabInfrastructure@Geo.X – A Search Portal for Laboratory Infrastructure - Manja Luzi-Helbing, GFZ German Research Centre for Geosciences, Geo.X
- "The Open Infrastructure Portal for DESY and HIFIS" - Tim Wetzel, Deutsches Elektronen-Synchrotron DESY
- "Replicable image analysis across domains" - Deborah Schmidt, Helmholtz Imaging, Max Delbrück Center MDC
- "The iDAI.world: an interconnected research infrastructure in an open science world" - Fabian Riebschläger, German Archaeological Institute DAI
- "SciLake: Assisting domain-specific applications on top of open SKGs - The OpenAIRE Graph use-case" - Paolo Manghi, OpenAIRE AMKE (Greece) and Institute of Information Science and Technologies, CNR (Italy)

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Towards Open Digital Research Ecosystems

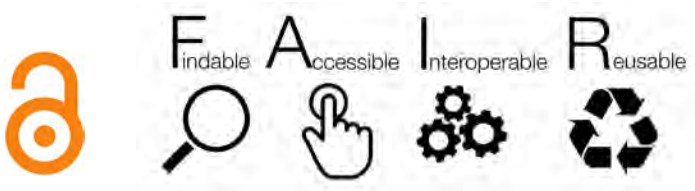
Open Science Forum

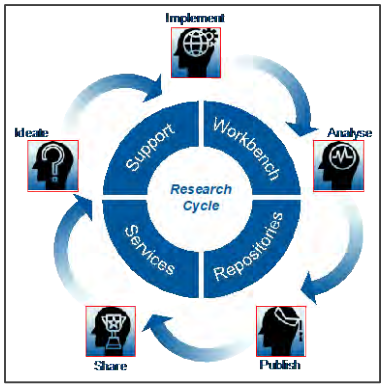
February 14, 2024

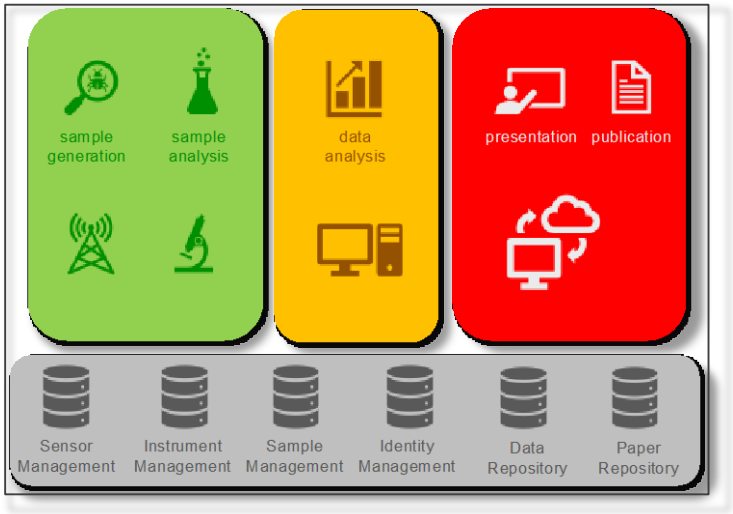
Wolfgang zu Castell
Department Geoinformation, GFZ

Open Science …

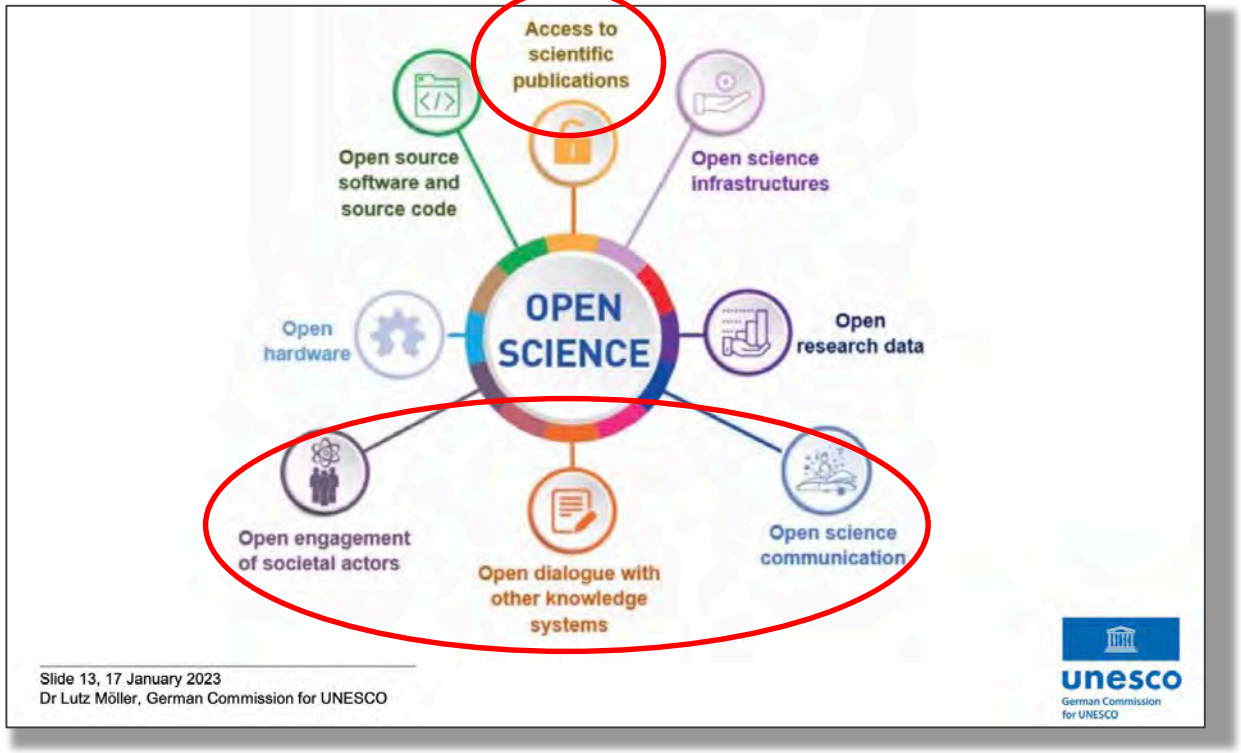
- is **not** Open Access
- is **not** FAIR
- is **fundamental** to the scientific method
- is fostering **digitalization**
- is also aimed at **non-scientific stakeholders**







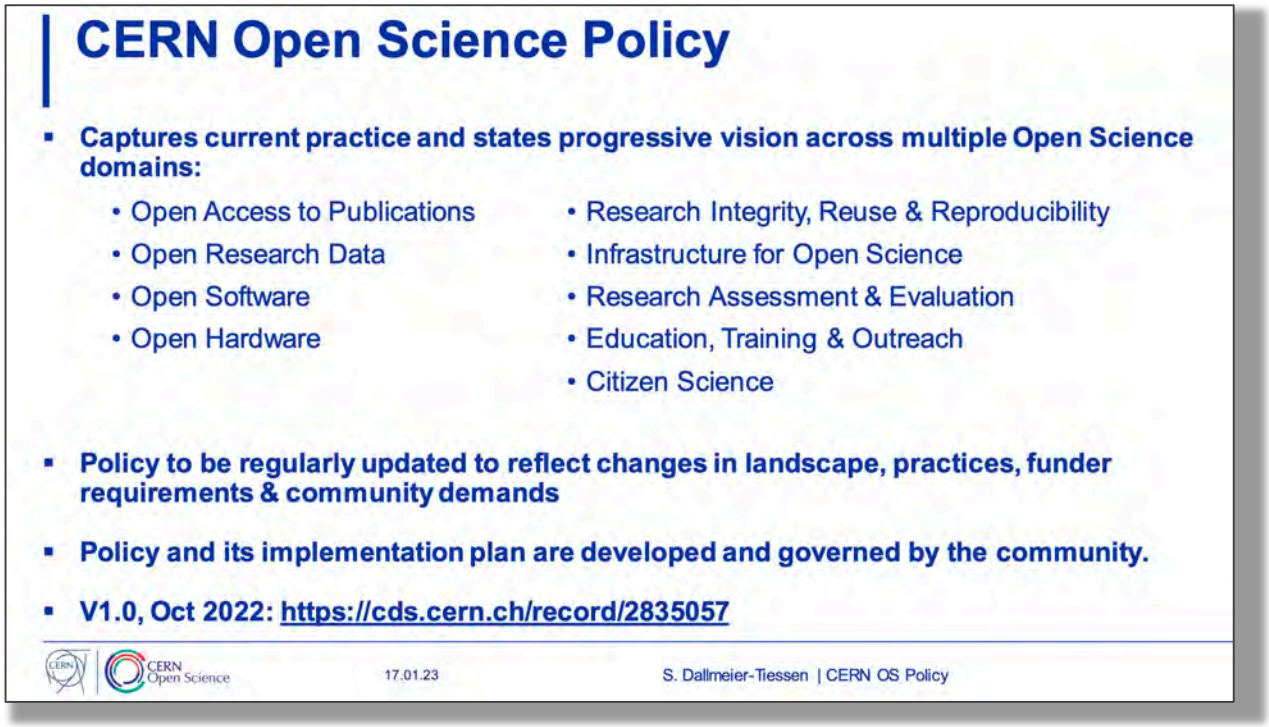
Open Science … the UNESCO approach

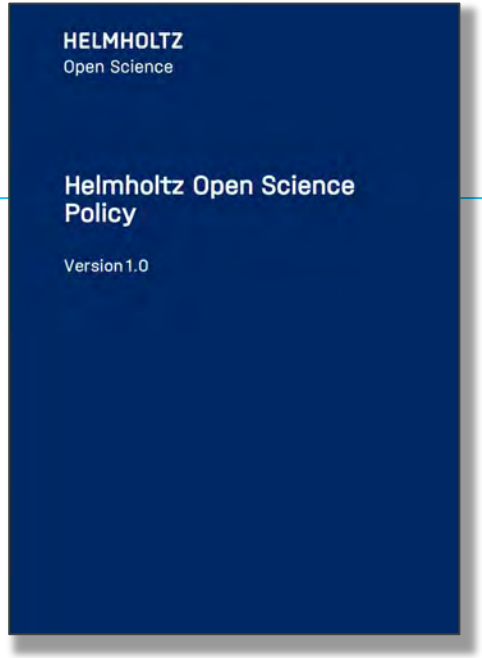


- much broader view
- including societal engagement
- building on dialogue

… thinking digitaliztion, this heavily relies on infrastructure!

Basis is layed out for a broader approach

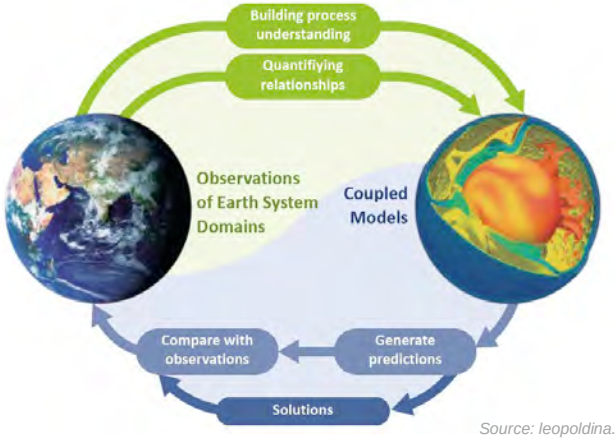




„*Openness by design*“ as guiding principle for building a **Digital Research Ecosystem**

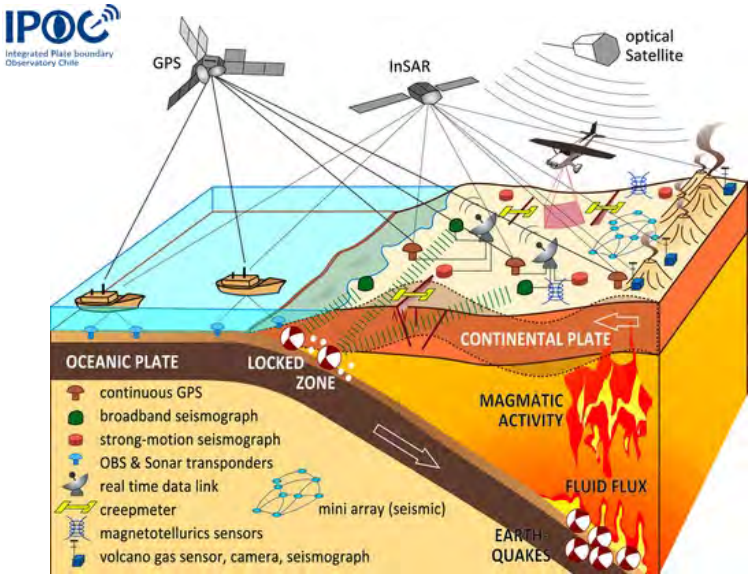
An Example: Earth System Science within Helmholtz

DataHub
Research Field Earth & Environment



Source: leopoldina.org

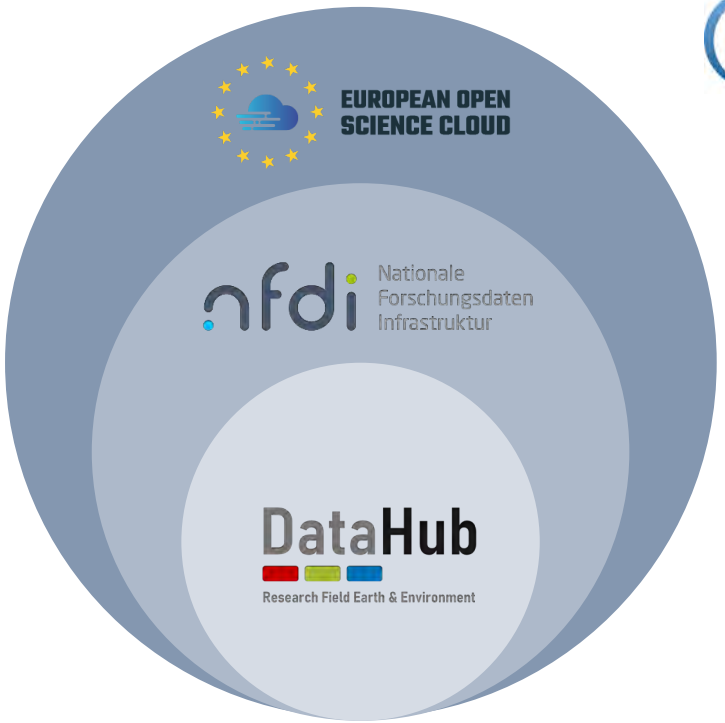
We are working in cross-disciplinary teams within international networks!



Source: ipoc-network.org

- need to bring together data and models
- scientists want immediately explore (i.e. work with data and models)
- prepare ourselves for new technologies (e.g. AI)

(Open?) Digital Research Ecosystem



- there are many initiatives with similar goals
- there are stakeholders outside of academia
- we must avoid to plant just yet another little plant in the jungle

Infrastructure for Open Science …

DataHub E&E/GFZ

within the digital ecosystem we find

- ✓ services dealing with the digital artefacts of the research process
- ✓ services enabling access, processing, storing, archiving …
- ✓ services enabling identification, harmonization, findability …

open science infrastructure

infrastructure for open science

Questions for Open Science …

- What infrastructures are **essential for open science**?
- How do we organize and guarantee **long-term sustainability**?
- How far are we able to go in terms of **open infrastructures** (end-to-end)?
- To what extent do we need to **harmonize** policies, guidelines, concepts, architectures?
- How do we deal with the **increasing level of automatization**?
- How do we deal with **new challenges** (see e.g. chatGPT et al.)?
- How do we deal with **threats** (e.g. IT security, geopolitical changes)?

Open Access by DESY and the role of preprints

Open Science Forum

Robert Thiele
0000-0001-8350-9942
Hamburg, 14th February 2024

https://bib-pubdb1.desy.de/record/602686

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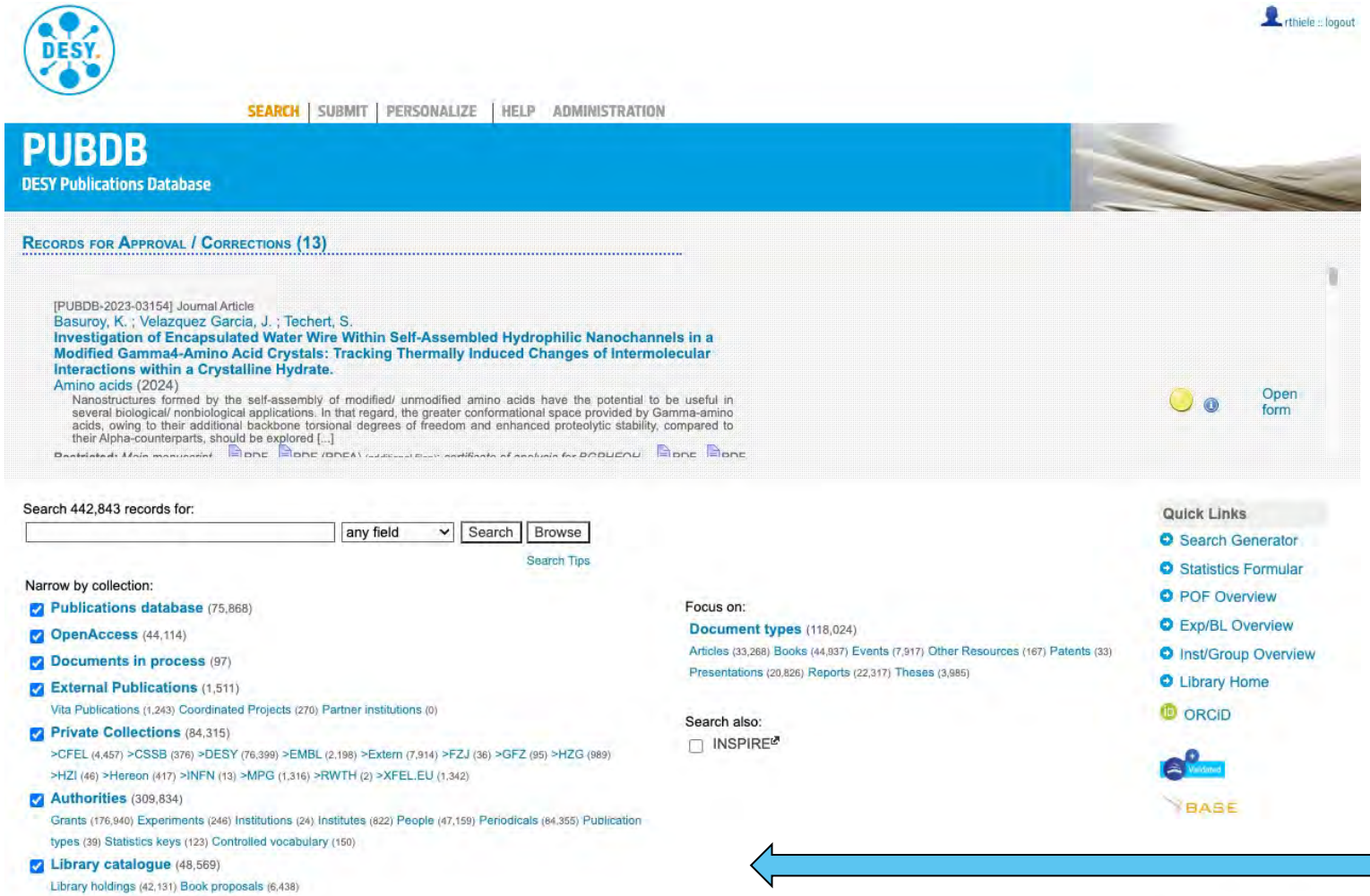
DESY.

PubDB – Der DESY Publikationsserver



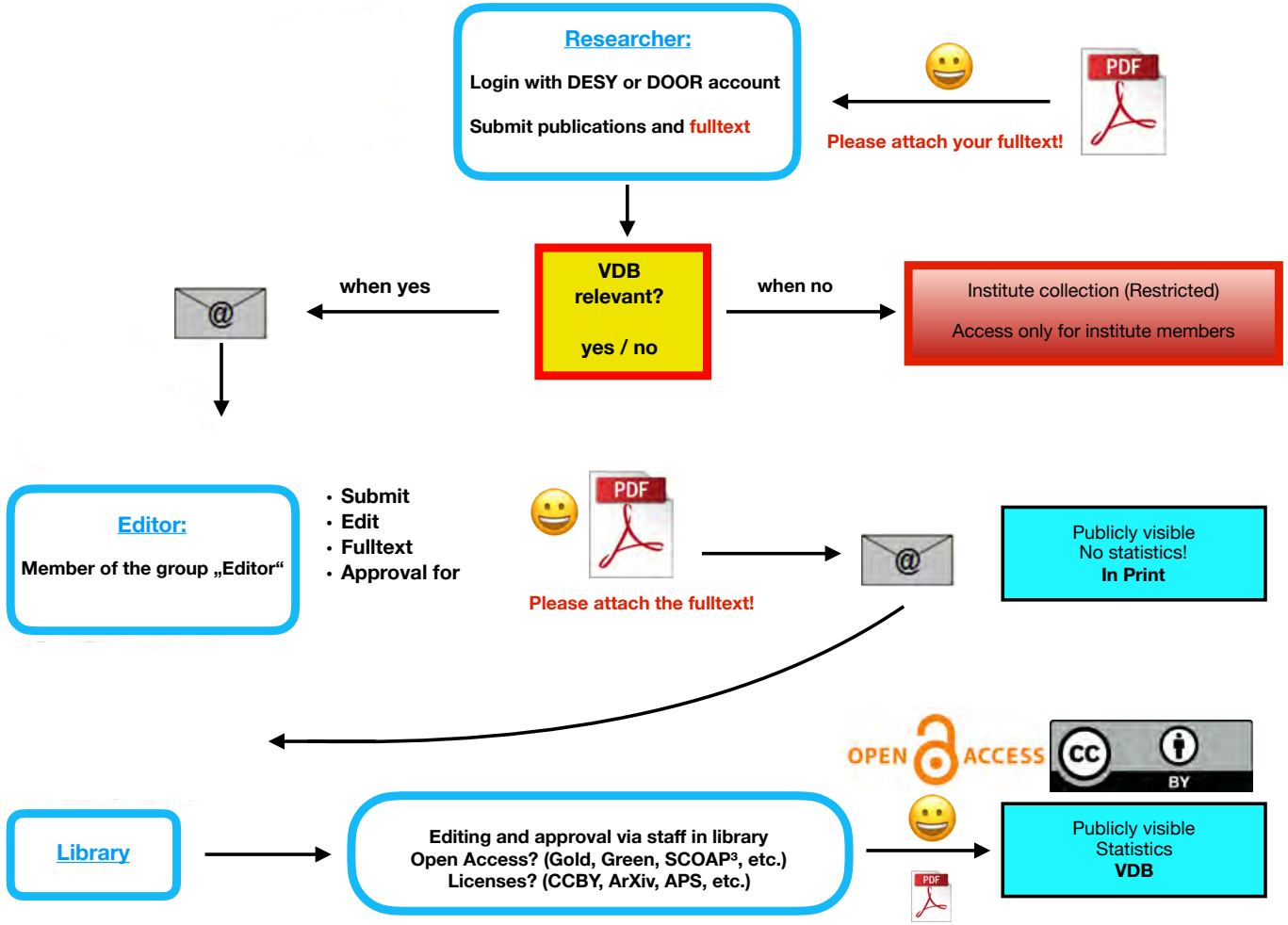
Approval module

Statistics module

Collections

join² = just another invenio instance

DESY PubDB – Workflow



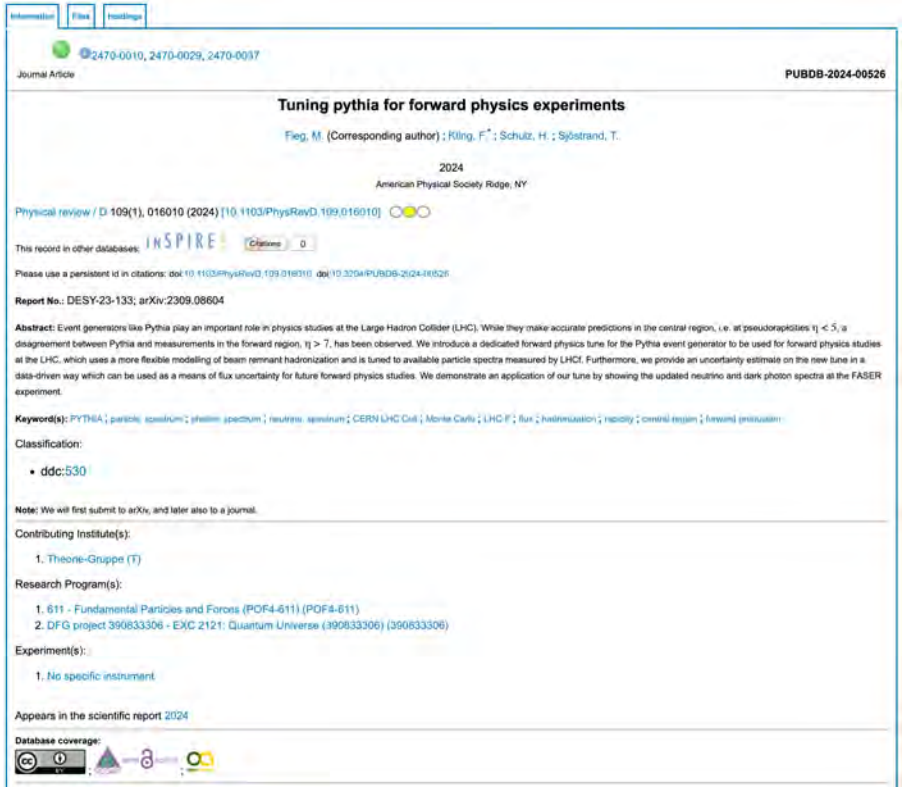
DESY Publication types

	Abstract	Dissertation / PhD Thesis	Internal Report	Journal Article	Lecture	Master Thesis	Bachelor Thesis	Poster	Preprint
610 - Matter and the Universe (POF IV: 2021 - 2026)	1	26	0	523	5	3	2	34	489
620 - Materie und Technologie (POF IV: 2021 - 2026)	15	6	2	97	1	1	1	31	37
630 - Von Materie zu Materialien und Leben (POF IV:...	0	13	0	429	0	0	0	1	16
6G0 - Großgeräte: Materie (POF IV: 2021 - 2026)	6	6	0	301	0	0	1	4	6
890 - ohne Programm (POF IV: 2021 - 2026)	0	0	0	2	0	0	0	2	2

- Over 90% of journals published as preprint in High Energy Physics by DESY
- Preprints approved for fast ArXiv uploading
- Two records for preprint and journal

Journal and preprint record

Over 90% of journals published as preprint in High Energy Physics by DESY
First approval for Preprints for fast ArXiv uploading



2470-0010, 2470-0029, 2470-0037

Journal Article

PUBDB-2024-00526

Tuning pythia for forward physics experiments

Fieg, M. (Corresponding author) ; Kling, F.* ; Schulz, H. ; Sjöstrand, T.

2024

American Physical Society Ridge, NY

Physical review / D 109(1), 016010 (2024) [10.1103/PhysRevD.109.016010]

This record in other databases: INSPIRE Citations 0

Please use a persistent id in citations: doi:10.1103/PhysRevD.109.016010 doi:10.3204/PUBDB-2024-00526

Report No.: DESY-23-133; arXiv:2309.08604

Abstract: Event generators like Pythia play an important role in physics studies at the Large Hadron Collider (LHC). While they make accurate predictions in the central region, i.e. at pseudorapidities $\eta < 5$, a disagreement between Pythia and measurements in the forward region, $\eta > 7$, has been observed. We introduce a dedicated forward physics tune for the Pythia event generator to be used for forward physics studies at the LHC, which uses a more flexible modelling of beam remnant hadronization and is tuned to available particle spectra measured by LHCf. Furthermore, we provide an uncertainty estimate on the new tune in a data-driven way which can be used as a means of flux uncertainty for future forward physics studies. We demonstrate an application of our tune by showing the updated neutrino and dark photon spectra at the FASER experiment.

Keyword(s): PYTHIA ; particle, spectrum ; photon, spectrum ; neutrino, spectrum ; CERN LHC Coll ; Monte Carlo ; LHC F ; flux ; hadronization ; rapidity ; central region ; forward production

Classification:

- ddc:530

Note: We will first submit to arXiv, and later also to a journal.

Contributing Institute(s):

1. Theorie-Gruppe (T)

Research Program(s):

1. 611 - Fundamental Particles and Forces (POF4-611) (POF4-611)
2. DFG project 390833306 - EXC 2121: Quantum Universe (390833306) (390833306)

Experiment(s):

1. No specific instrument

Appears in the scientific report 2024

Database coverage:

Preprint

PUBDB-2023-05595

Tuning Pythia for Forward Physics Experiments

Fieg, M. (Corresponding author) ; Kling, F.* ; Schulz, H. ; Sjöstrand, T.

2023

[10.3204/PUBDB-2023-05595]

This record in other databases: INSPIRE Citations 7

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Research Program(s):

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iverse (390833306) (390833306)

Linked articles:

Journal Article

Fieg, M. (Corresponding author) ; Kling, F.* ; Schulz, H. ; Sjöstrand, T.

Tuning pythia for forward physics experiments

Physical review / D 109(1), 016010 (2024) [10.1103/PhysRevD.109.016010]

OPEN ACCESS Files Fulltext by arXiv.org

DESY-FH Newsletter

4. Publikationen der letzten Wochen

Preprints

- ATLAS Kollaboration (Früd Braren (DESY), Cyril Becot und Stefan Richter (ehemals DESY), **Differential cross-section measurements of the production of four charged leptons in association with two jets using the ATLAS detector**.
https://arxiv.org/abs/2308.12324

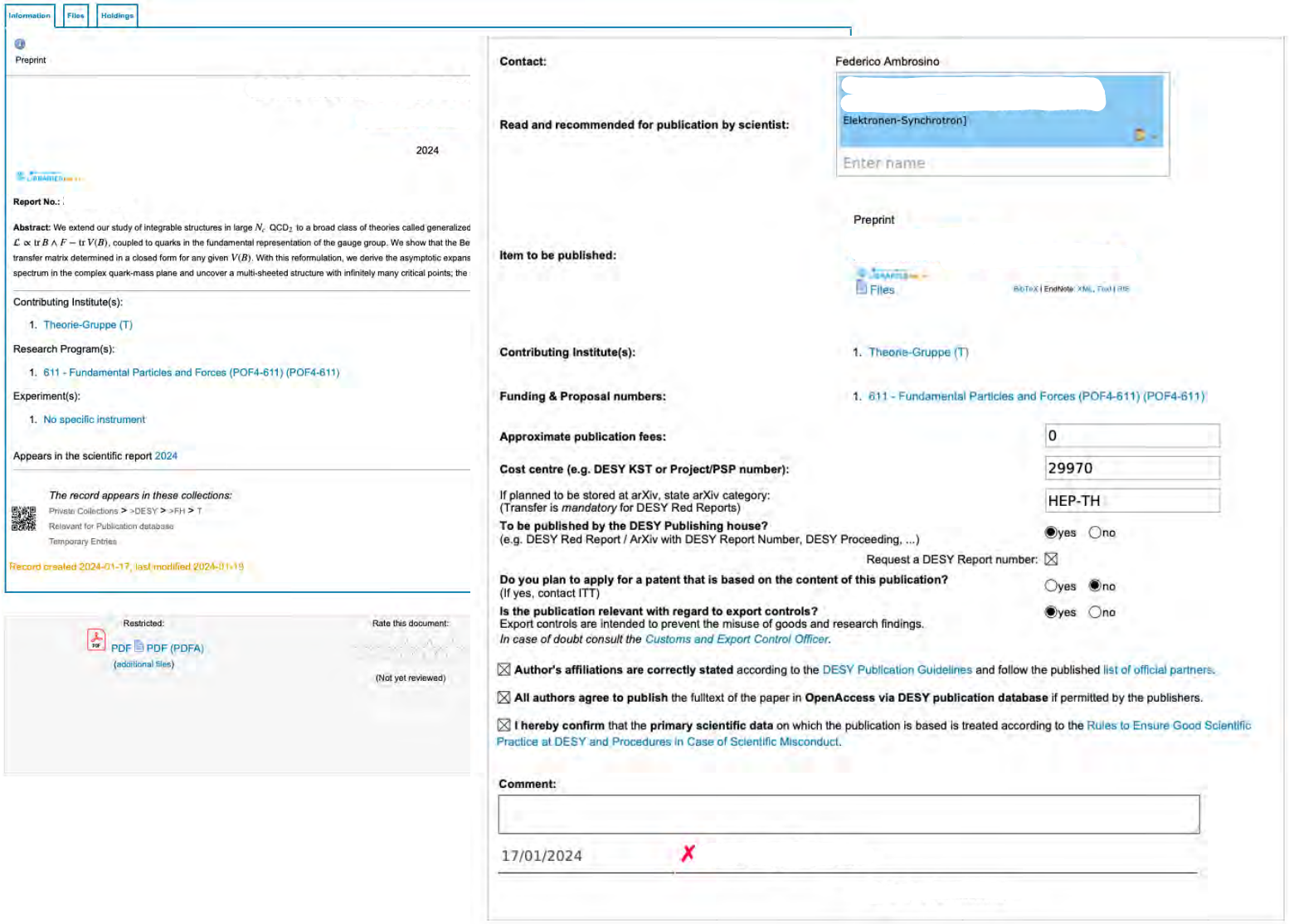
- Alexandrou, C. *et al.*, **Pion Transition Form Factor from Twisted-Mass Lattice QCD and the Hadronic Light-by-Light π^0-pole Contribution to the Muon $g-2$.**
https://arxiv.org/abs/2308.12458

- CMS Kollaboration (Andreas Meyer und David Walter (jetzt CERN) vom DESY Team), **Luminosity determination using Z boson production at the CMS experiment.**
https://arxiv.org/abs/2309.01008

- Dehnadi, B., Hoang, A. H., Jin, O. L. & Mateu, V., **Top Quark Mass Calibration for Monte Carlo Event Generators – An Update**.
https://arxiv.org/abs/2309.00547

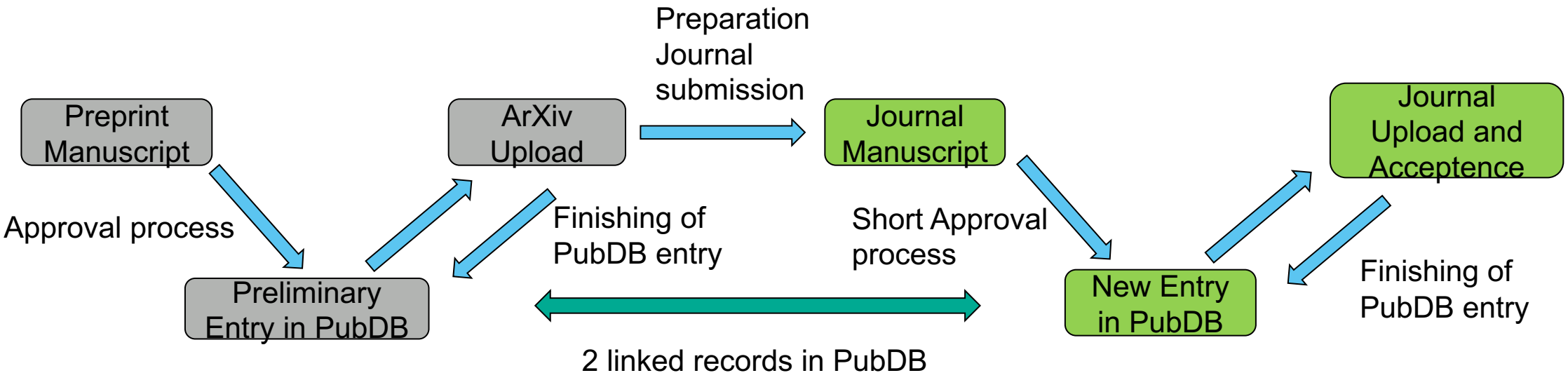
- 2-weekly newsletter with lists of new ArXiv publications
- We use search in INSPIRE and in our repository PubDB
- Missing preprints import by DESY Library to send DESY groups for information and completion
- Advantage of FH newsletter: completeness of preprints in repository
- Normally, DESY Library receives new preprints as approval

DESY approval



- For each publication, e.g. Journal article, Contributions to a conference proceedings, Preprints etc. approvals for DESY scientists are necessary
- DESY directorate, group leader, staff members have different permissions
- Preprint can approved by group leader / staff member
- each ArXiv submission should be approved
- Separate data set for preprints due to different time span between preprint and journal article and different people granting permission
- formal verification of DESY affiliation by DESY Library

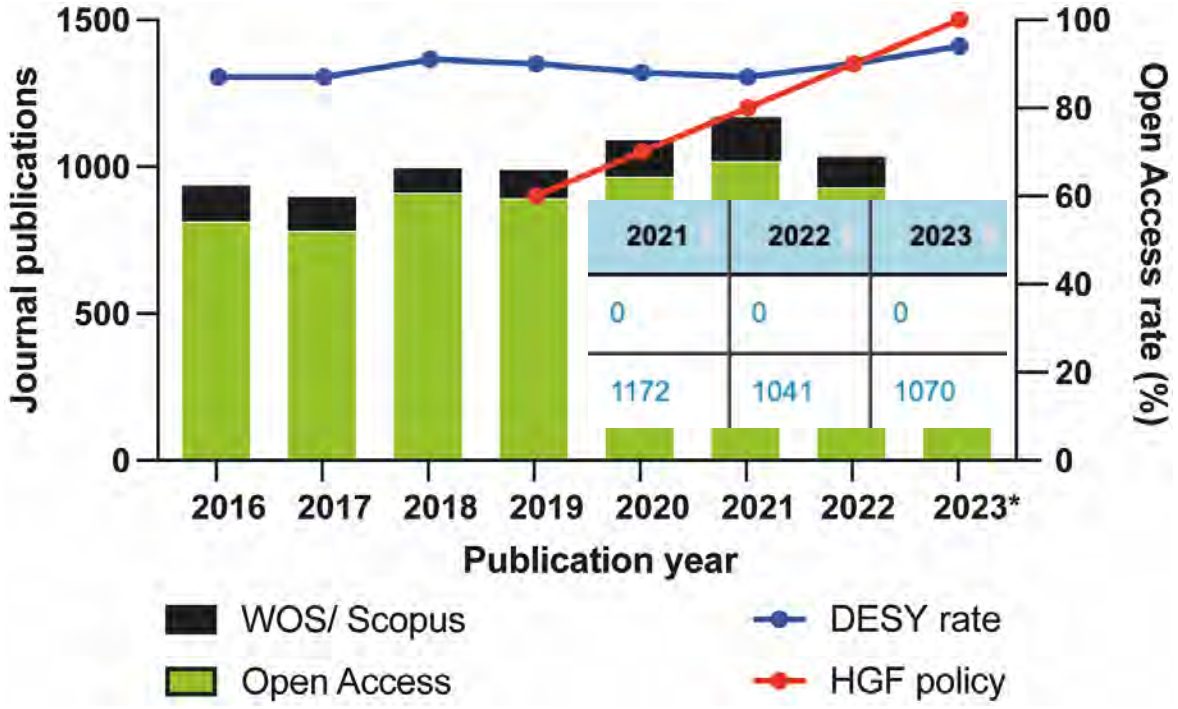
Preprint and Journal workflow



Preprints as part of Open access strategy

- DESY Web of Science / Scopus listed Journal publications 2016-2023 and there Open Access part
- Number of 2023 is preliminary
- DESY OA rate 2016-2023 and HGF policy from 2019-2023

- Publication number increases the last years
- DESY OA rate slight increasing
- Small gap of 5% in 2023
- For reporting OA rate 2013 deadline is 31th December 2024



Preprint is important part to fulfil the HGF OA goal!

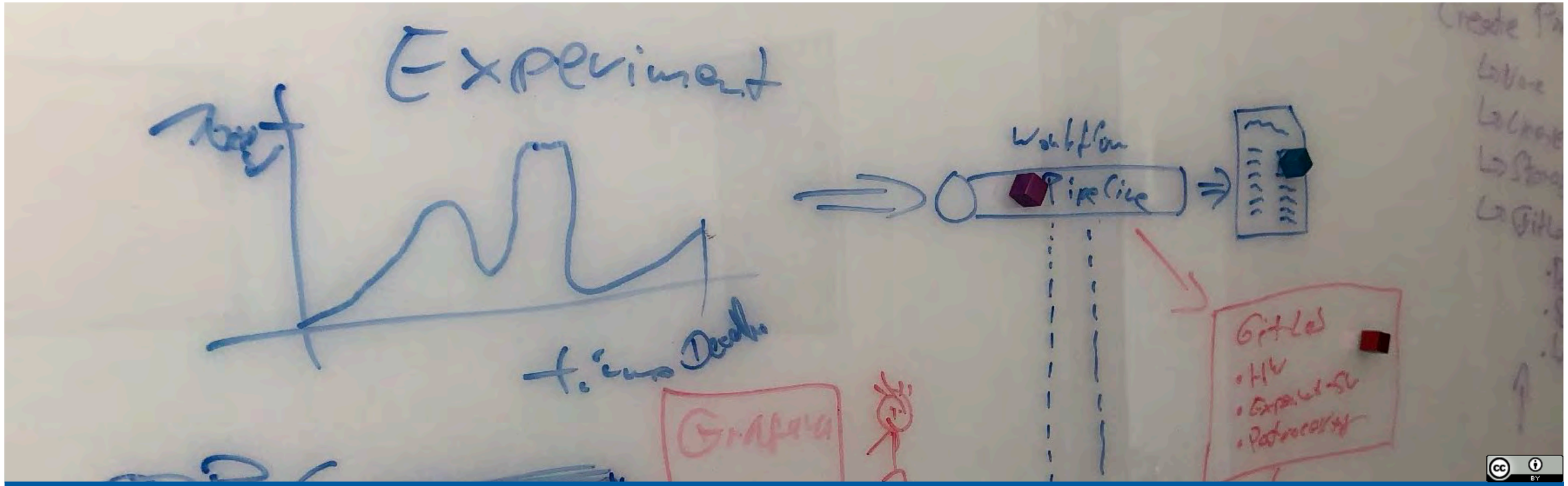
Thank You

Kontakt

Deutsches Elektronen-
Synchrotron DESY

www.desy.de

Robert Thiele
DESY Library
robert.thiele@desy.de
040 89981927



Pioneering Digital Research Landscapes: Innovations at HZDR

Towards Open Digital Research Ecosystems – Interconnecting Infrastructures, Open Science Forum, February 14, 2024

Oliver Knodel // contact: o.knodel@hzdr.de

Our Research Facility and our Large Scale Research Infrastructures

The Helmholtz-Zentrum Dresden - Rossendorf

— Employees approx. 1,470. Thereof 670 scientists

— HELMHOLTZ
RESEARCH FOR GRAND CHALLENGES

Research Fields

— Energy, Health and Matter

ELBE – Center for High-Power Radiation Sources

— Electron accelerator, free-electron lasers & THz source.

— Positrons, protons, neutrons as well as X-ray and gamma radiation

Dresden High Magnetic Field Laboratory (HLD)

— Europe’s highest pulsed magnetic fields

Ion Beam Center (IBC)

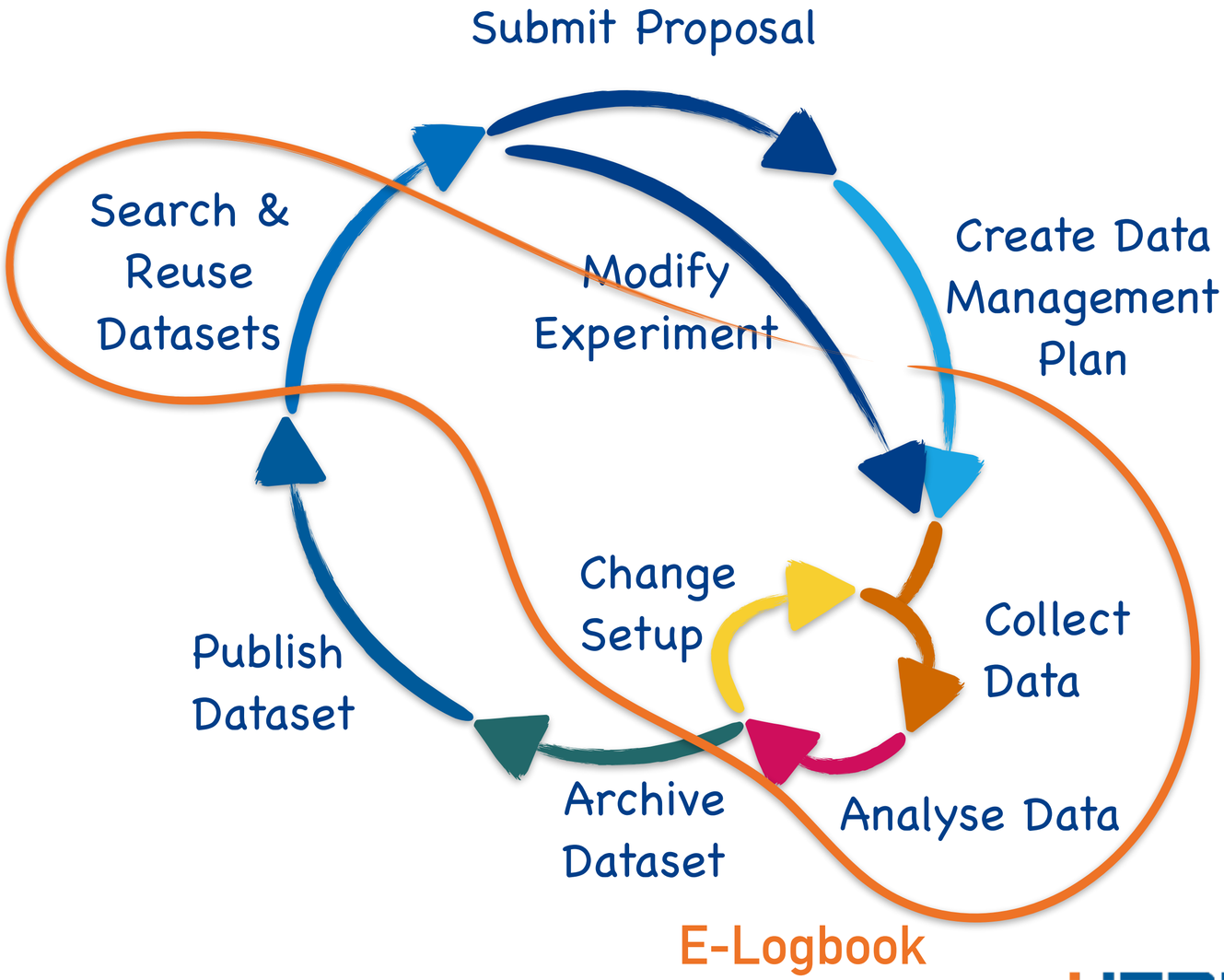
— Nanoscale surface analysis and modification

Our Challenge: An End-to-End Digital Data Lifecycle

— We support many steps of our different research experiment (matter, energy and health) with a wide range of tools:
  - Electronic lab notebook (**E-Logbook**),
  - Interactive analysis,
  - **FAIR Publication** of datasets,
  - Scientific **workflow** management,
  - **Handle** (PID) generation and management.

— A uniform and smooth access to and **between** all services and systems in our ecosystem is necessary.

— The documentation of all these linked resources is essential to create a **comprehensible** and **FAIR** data lifecycle.



The Foundation for our Digital Data Lifecycle: HZDR Data Policy

— The HZDR has a data policy since **May 2018**

— Reasons for the development:

- Legal framework for data management and publication,
- Establishment and legitimisation of coordinated research data management. at HZDR,

— Foundation for the development of tools and services to support our scientists:

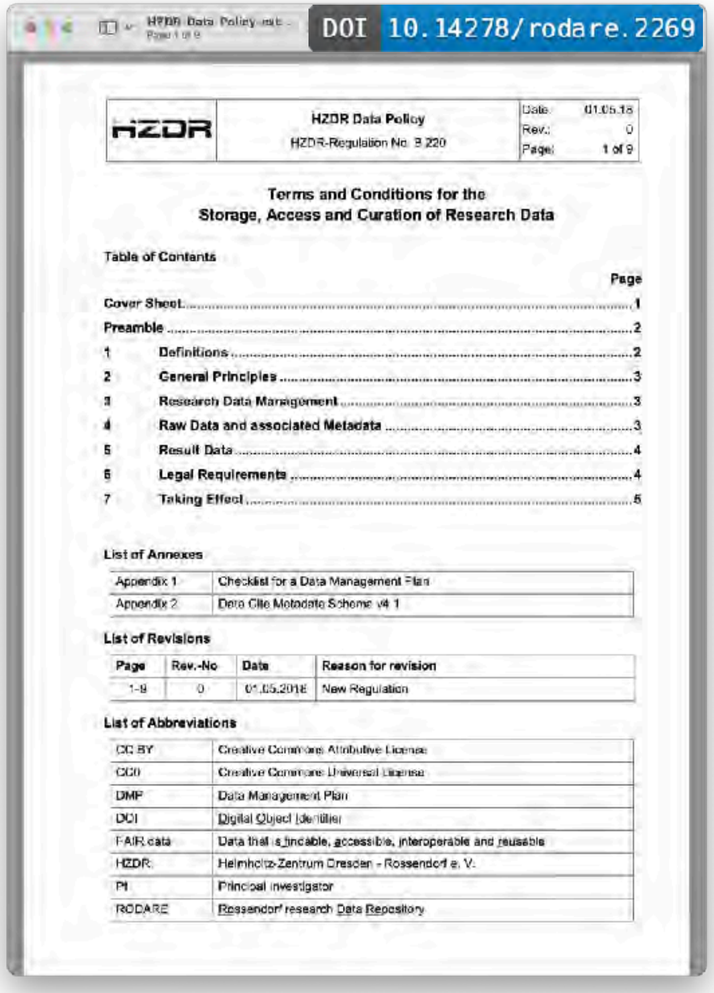
RODARE
ROSSENDORF DATA REPOSITORY

ROBIS
PUBLICATION REPOSITORY

HELIPORT HELmholtz Scientific Project WORkflow PlaTform

HERMES

© Helmholtz-Gemeinschaft 2023, https://os.helmholtz.de/open-research-data/forschungsdaten-policies/


DOI 10.14278/rodare.2269

HZDR | HZDR Data Policy | Date: 01.05.18
HZDR-Regulation No. B 220 | Rev.: 0 | Page: 1 of 9

Terms and Conditions for the Storage, Access and Curation of Research Data

Table of Contents

		Page
Cover Sheet		1
Preamble		2
1	Definitions	2
2	General Principles	3
3	Research Data Management	3
4	Raw Data and associated Metadata	3
5	Result Data	4
6	Legal Requirements	4
7	Taking Effect	5

List of Annexes

Appendix 1	Checklist for a Data Management Plan
Appendix 2	Data Cite Metadata Schema v4.1

List of Revisions

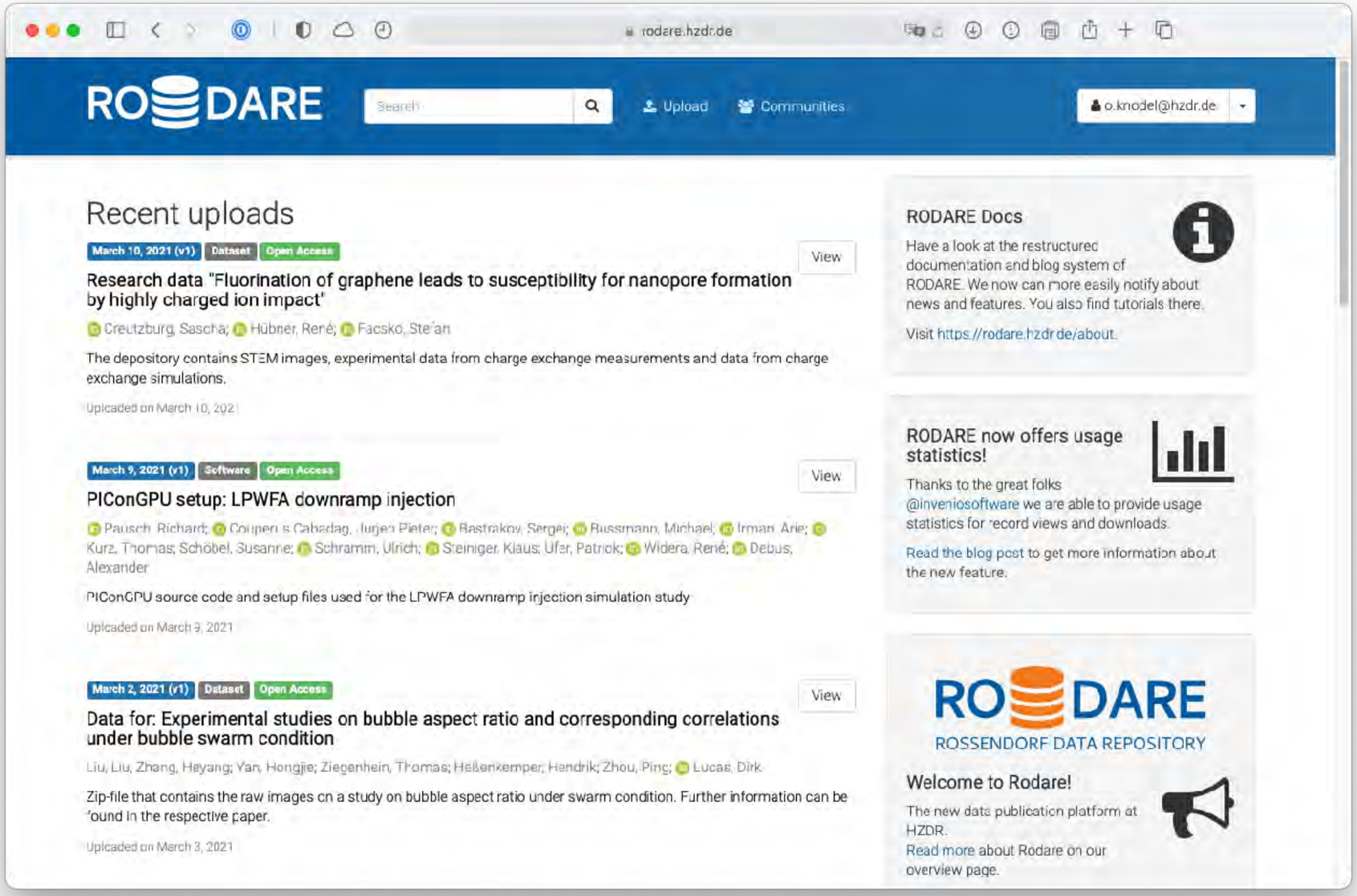
Page	Rev.-No	Date	Reason for revision
1-9	0	01.05.2018	New Regulation

List of Abbreviations

CC BY	Creative Commons Attributive License
CC0	Creative Commons Universal License
DMP	Data Management Plan
DOI	Digital Object Identifier
FAIR data	Data that is findable, accessible, interoperable and reusable
HZDR	Helmholtz-Zentrum Dresden - Rossendorf e. V.
PI	Principal investigator
RODARE	Rossendorf research Data Repository

Starting Point in 2018: Data Publication Platform RODARE

rodare.hzdr.de



Powered by:

zenodo

INVENIO

Registered in:

re3data.org
REGISTRY OF RESEARCH DATA REPOSITORIES

http://doi.org/10.17616/R3BR40

Findable with:

B2FIND

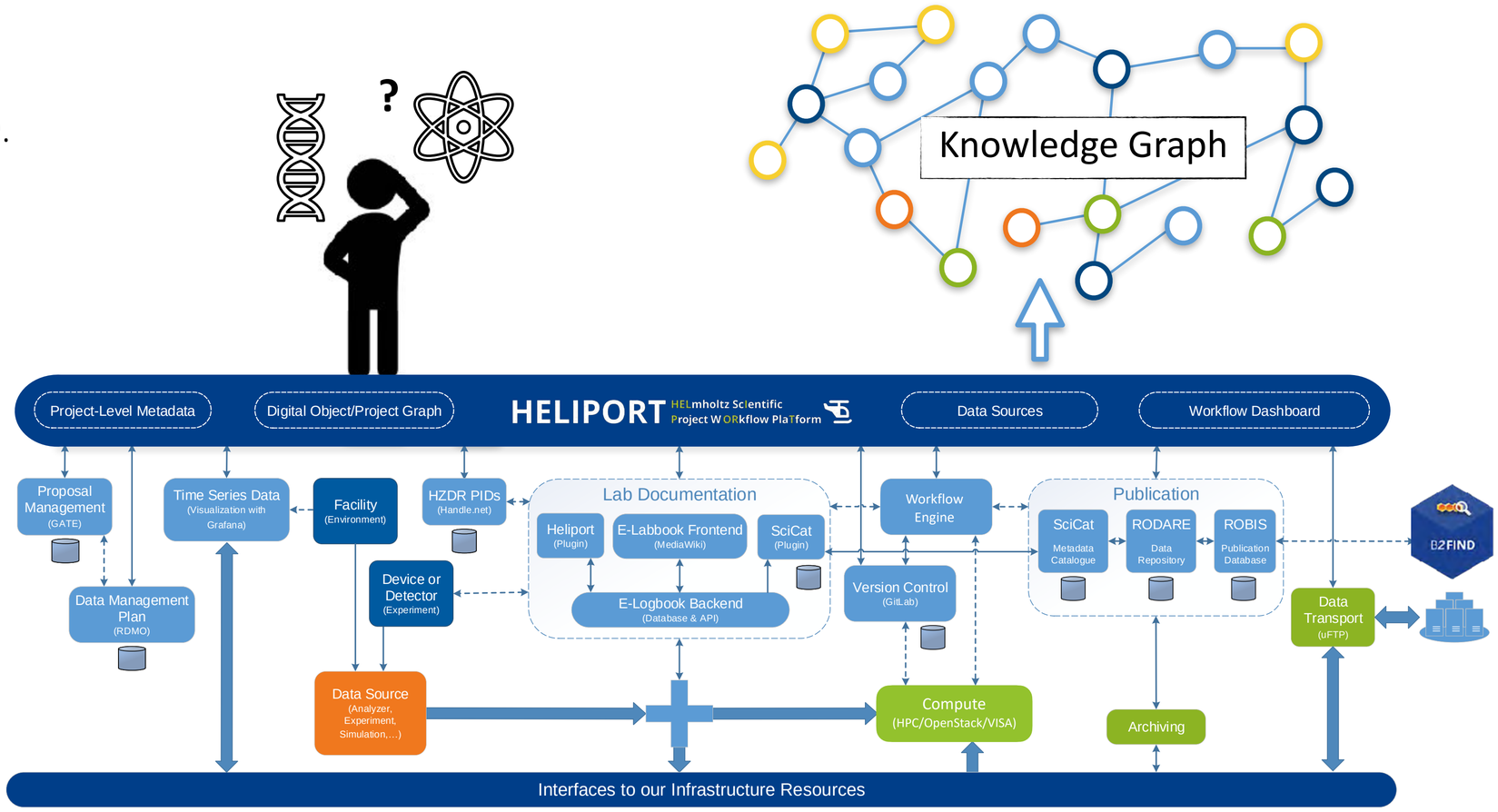
EUDAT

DRESDEN concept

HZDR

Our Observations Over the Following Years…

- We need to support the entire experiment with reliable **interconnected tools** to enable comprehensible and FAIR science.
- The resulting IT infrastructures are complex.
- Documentation is necessary, but typically time is missing.
- Scientists often don't know which services are available at facilities and how to use them.
- An overarching system **guiding our scientists** (and visitors) through the lifecycle of their research project is essential.



HELIPORT HELmholtz Scientific Project WORkflow PlaTform

heliport.hzdr.de

> The HELIPORT project aims at developing a platform which accommodates the **complete life cycle** of a scientific project and links all corresponding programs, systems and workflows to create a more **FAIR** and comprehensible project description.

Project Members:

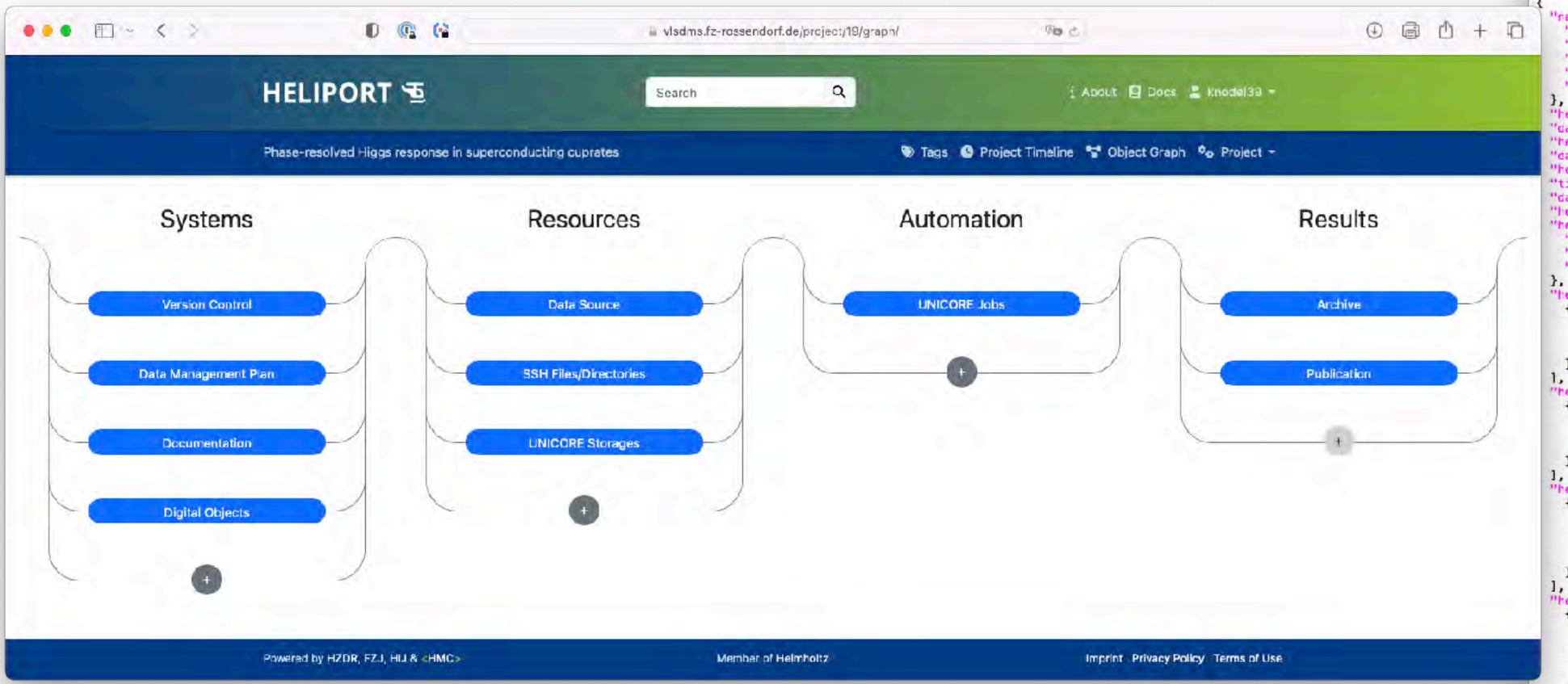
HZDR HELMHOLTZ ZENTRUM DRESDEN ROSSENDORF

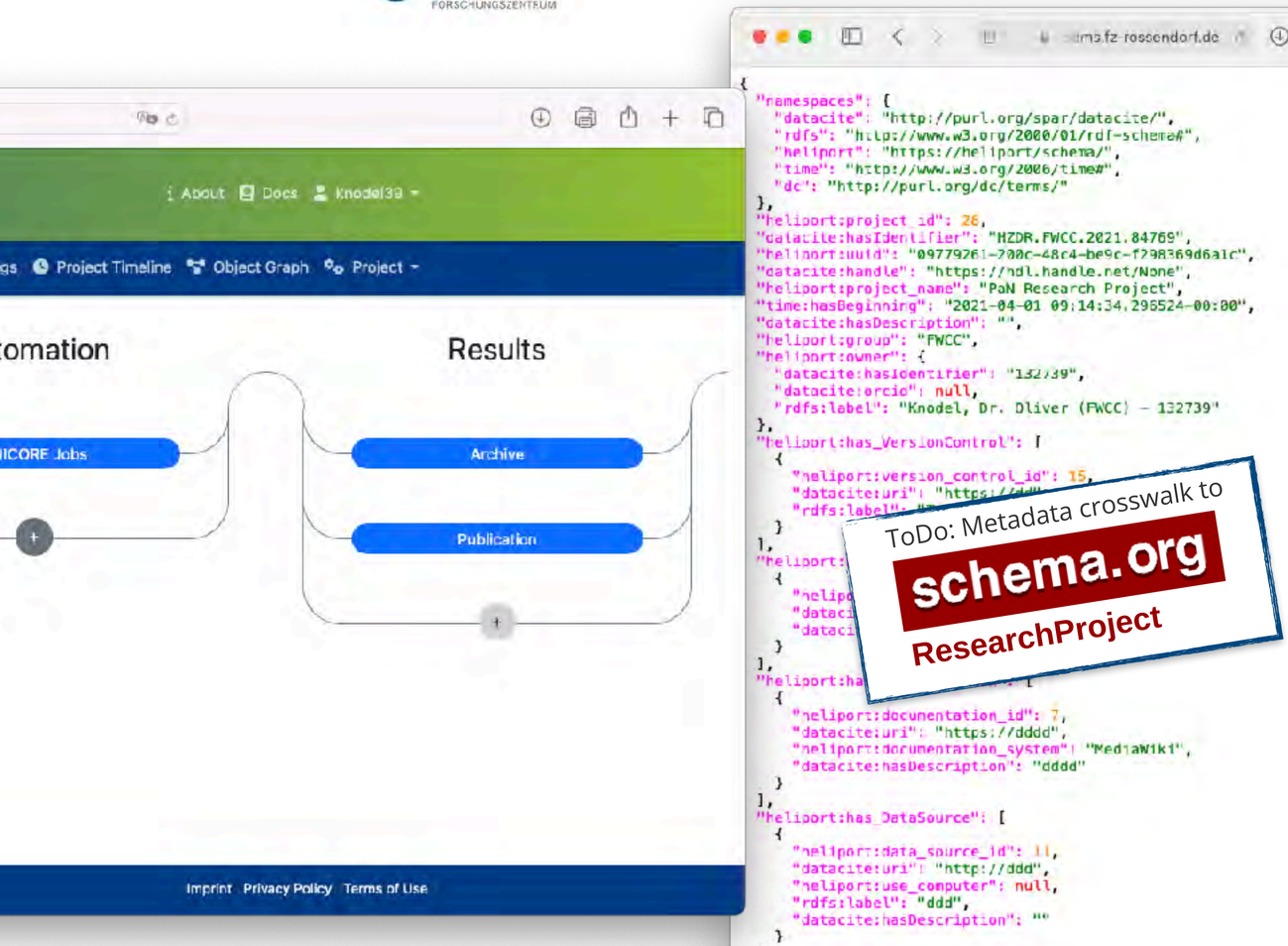
HI JENA Helmholtz Institute Jena

JÜLICH FORSCHUNGSZENTRUM

Funded by:

HMC HELMHOLTZ Metadata Collaboration



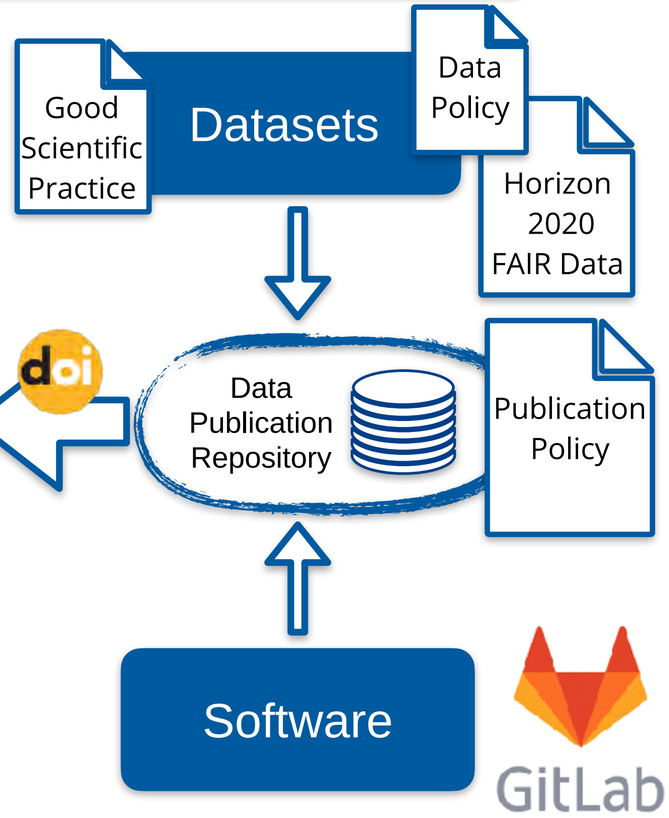


Requirements and Expectations

- HELIPORT was intended to provide only the **proposal's metadata**, from internal and external scientists, to allow the assignment of resources.
- Over time, we realised that HELIPORT can also answer our scientists' most important questions, such as:

And how we can support them?!

What are the necessary steps towards a full comprehensible and FAIR research experiment ensuring data provenance?



How can we **automate recurring processes** and keep track of status and data products?

Which datasets or software can be **published** (and how)?

How can we bring **new team members** or **visiting/external scientists** into our project lifecycle and all associated tools?

Where are data, software and how can I gain **access** to both of them?

HZDR

Example: HELIPORT Supported Experiment at The TELBE Beamline

- HELIPORT provides access to our services and guides **external/visiting scientists** through the entire experiment.
- This requires the experiment to be mapped to systems in the HZDR infrastructure.

Proposer (Principle Investigator)

III. Register (Helmholtz AAI)

Experimental Team (Visiting Scientists)

IV. Access/Use

I. Apply

Public

Scientific Publication

Registred

Cites

Project-Level Metadata | Digital Object/Project Graph | HELIPORT HELmholtz Scientific Project WORkflow PlaTform | Data Sources | Workflow Dashboard

Proposal Management (GATE)

Data Management Plan (RDMO)

Time Series Data (Visualization with Grafana)

Facility (Environment)

HZDR PIDs (Handle.net)

Lab Documentation

Heliport (Plugin)

E-Labbook Frontend (MediaWiki)

SciCat (Plugin)

E-Labbook

Workflow (HPC Cluster)

WorkflowHub.eu

Publication

SciCat Metadata Catalogue

RODARE Data Publication

ROBIS Publication Database

B2FIND

DAQ LabView

Automated logging

> 10GB per min

HZDR Beamline Scientist

II. Configure

Data Source (Cluster Storage, network drive)

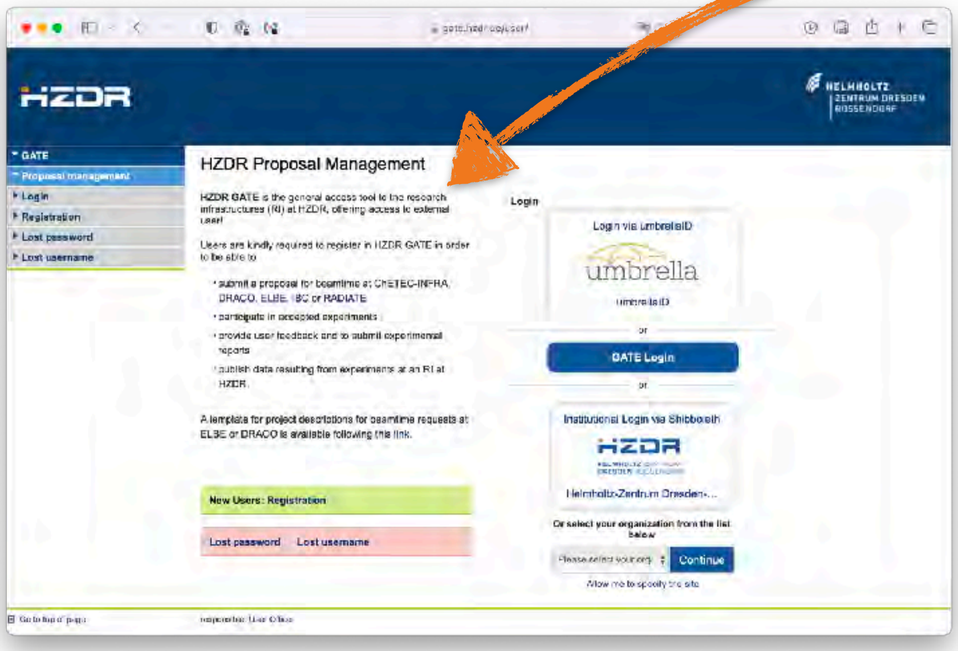
Data analysis

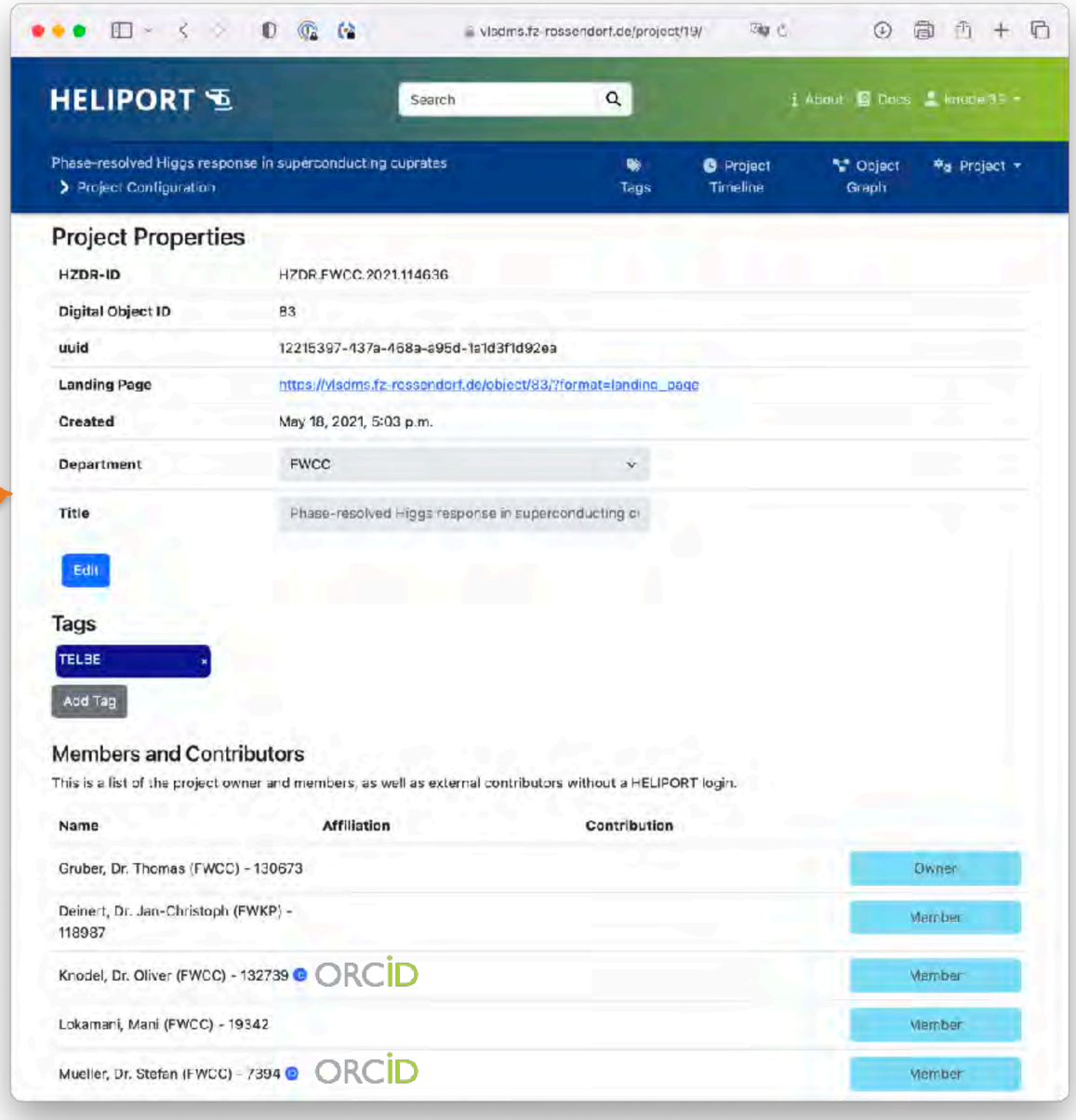
Data Analysis: Sorting, Binning (HPC/OpenStack)

I. Proposal Submission

Automated transfer of project metadata from the proposal system (GATE) into HELIPORT:

- Title, Authors, Description,
- Beamtime schedule,
- Large-scale facility used,
- Scientific method (PaNET)

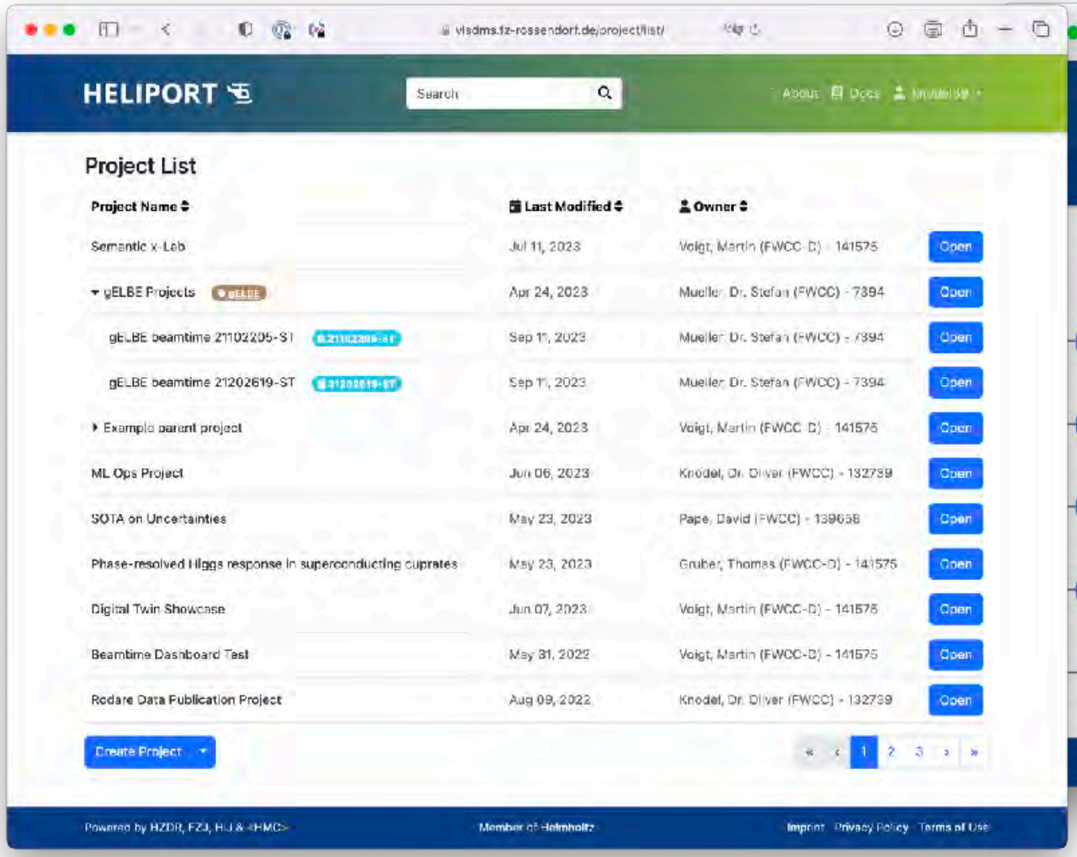


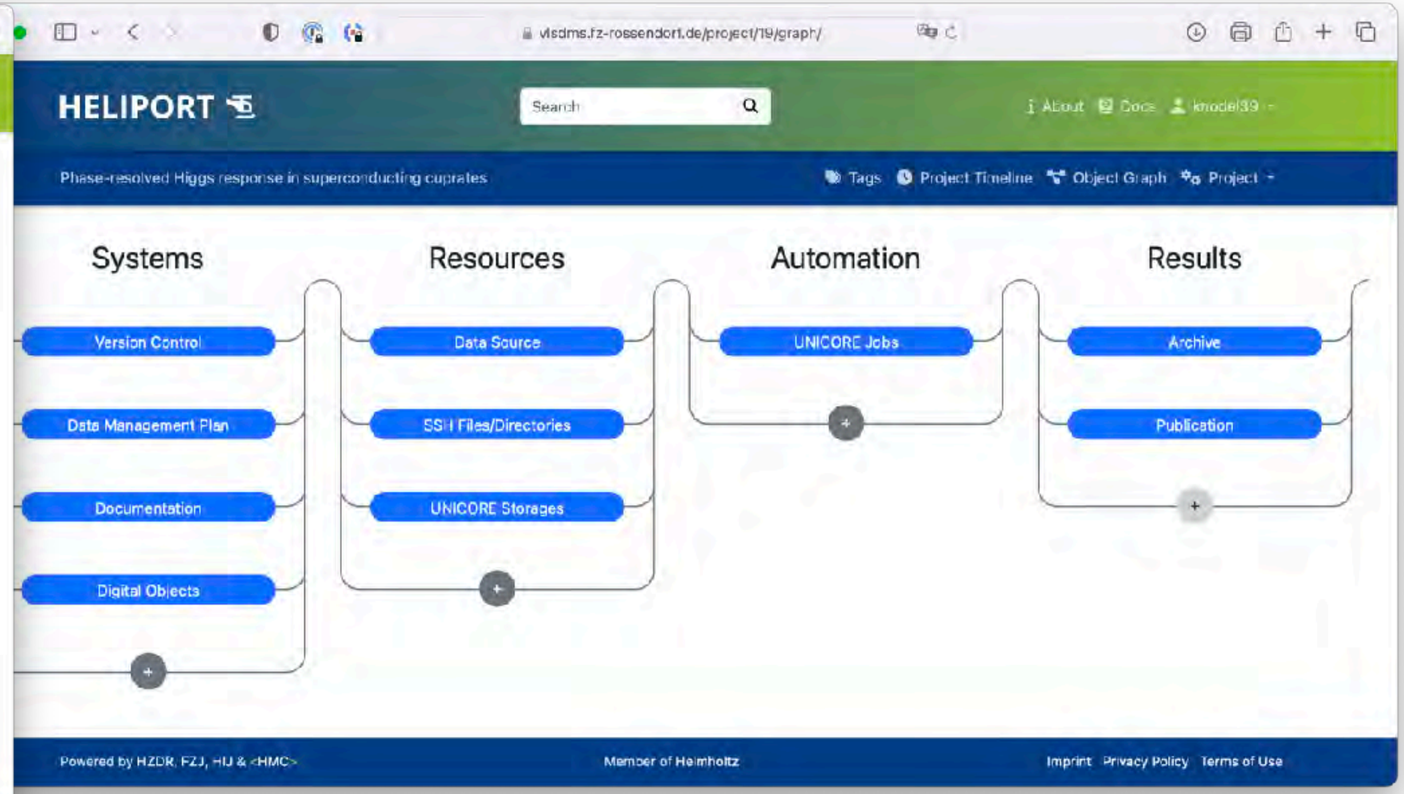


II. Project List and Dashboard

— Typically, a beam line scientist is the owner of a HELIPORT project and the proposer has the role of the manager and can add additional project members.

— Tags and sub-projects including inheritance are possible in the project list.



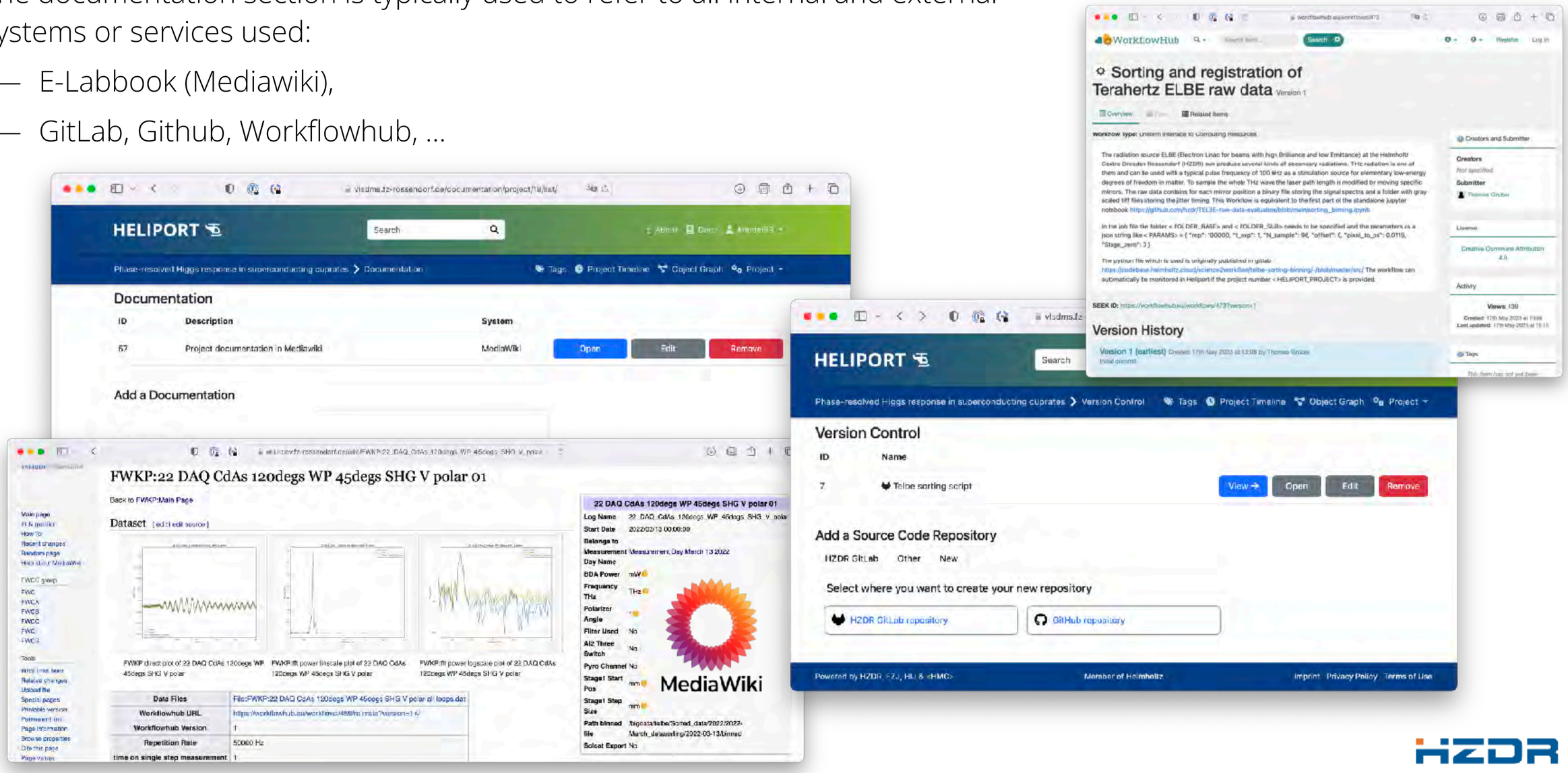


III. Resources: Documentation and Repositories

The documentation section is typically used to refer to all internal and external systems or services used:

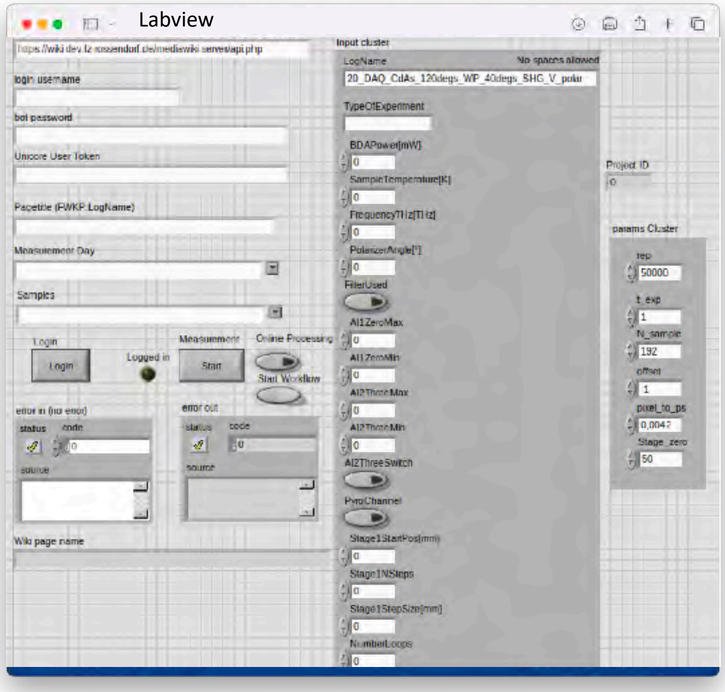
— E-Labbook (Mediawiki),

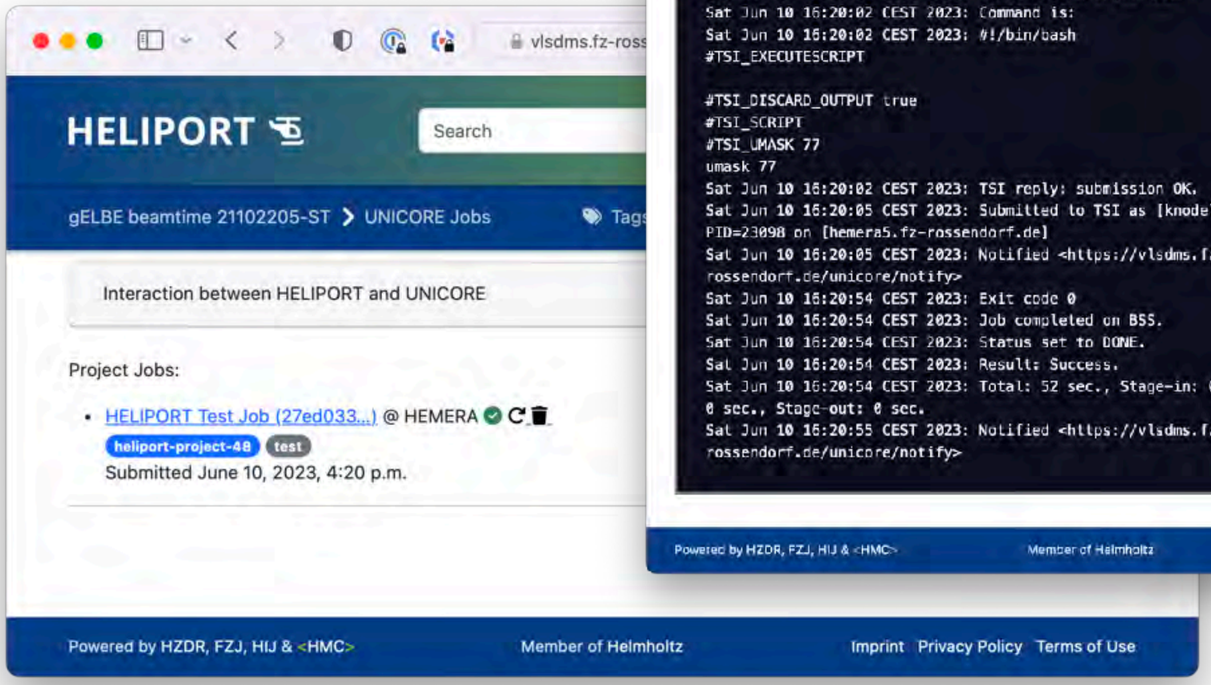
— GitLab, Github, Workflowhub, …



IV. Detector Control and Workflows

- The **HELIPORT REST-API** enables the transfer of metadata between HELIPORT and external systems (e.g. detector control in LabView).
- The integrated job/workflow submission system collects metadata with **provenance information** provided by HELIPORT.
- Workflows (on our HPC cluster) can be accessed by any project member using the HELIPORT web frontend.



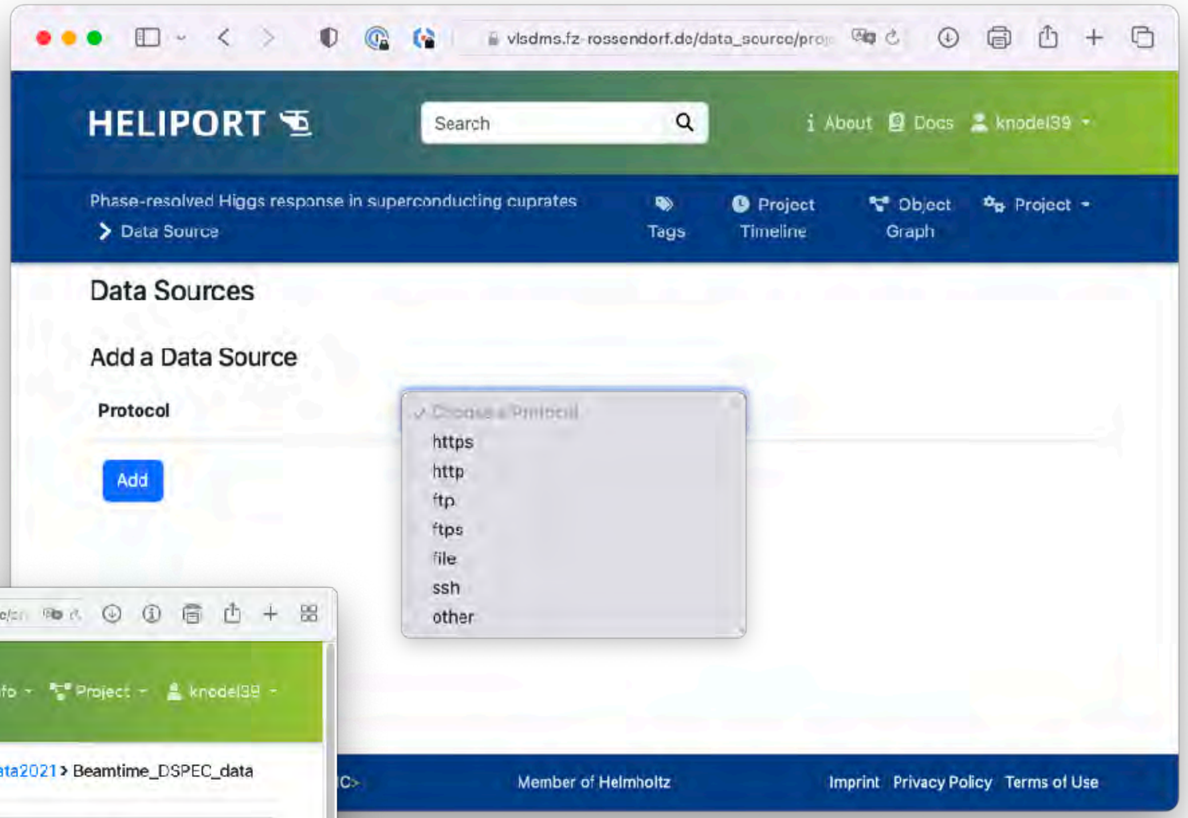


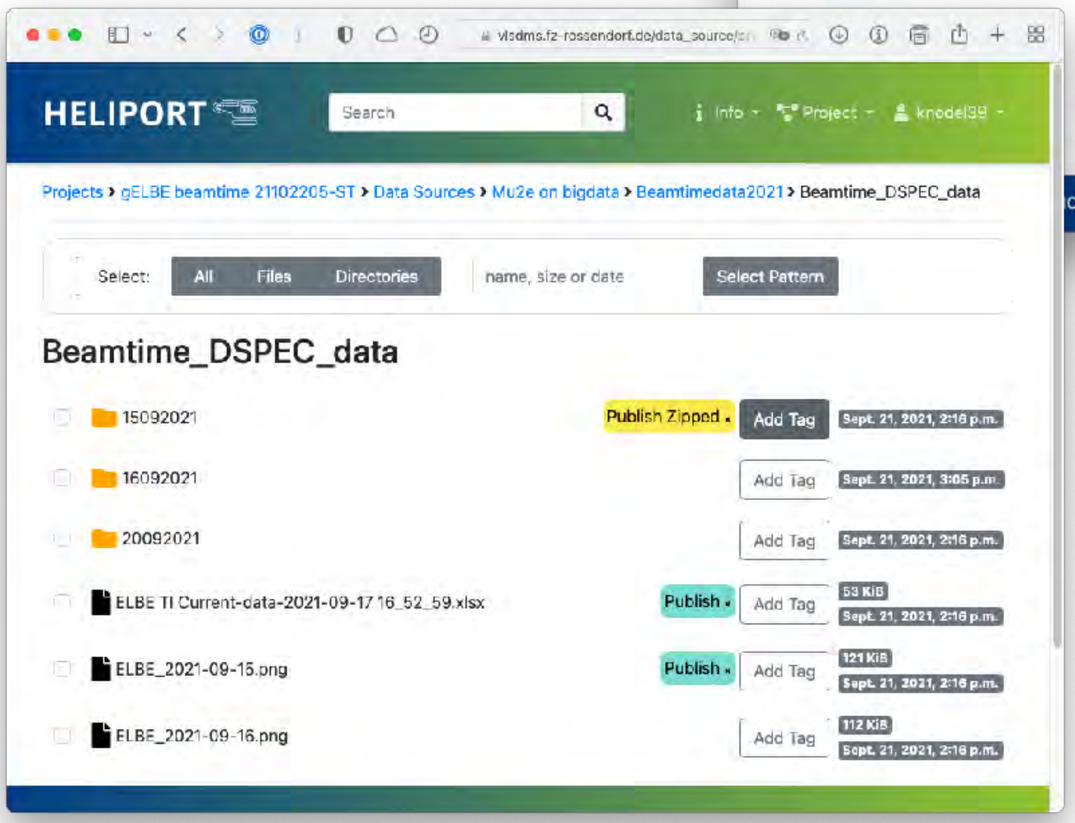
V. Data Sources

— Folders and files in our internal filesystems can be registered in HELIPORT as **data source**.

— Each **project member** has access to the files and folders using HELIPORT.

— The provenance of the data sets generated from an experiment is entirely comprehensible.

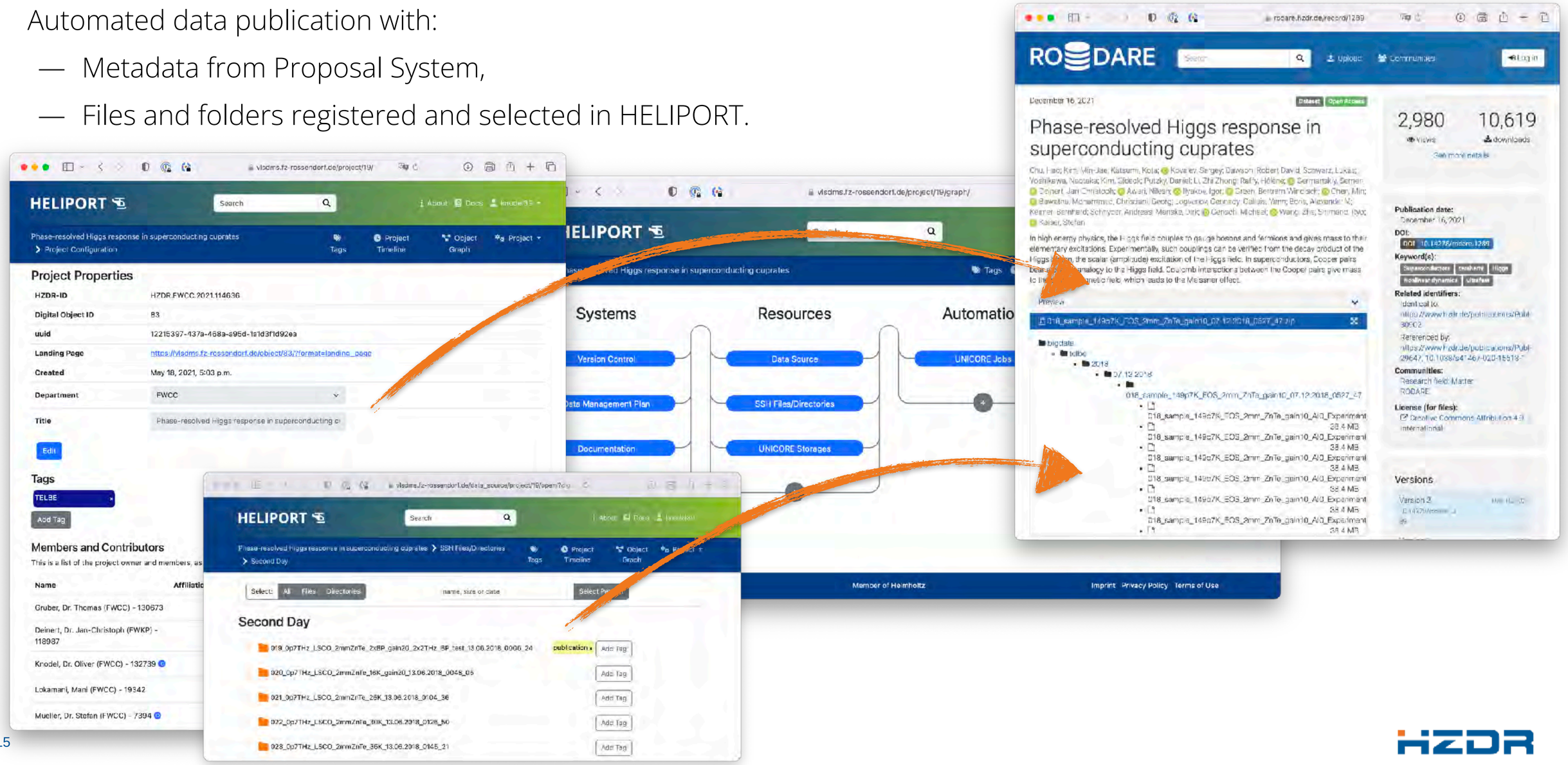




VI. Integration in an Overall Data Publication Workflow

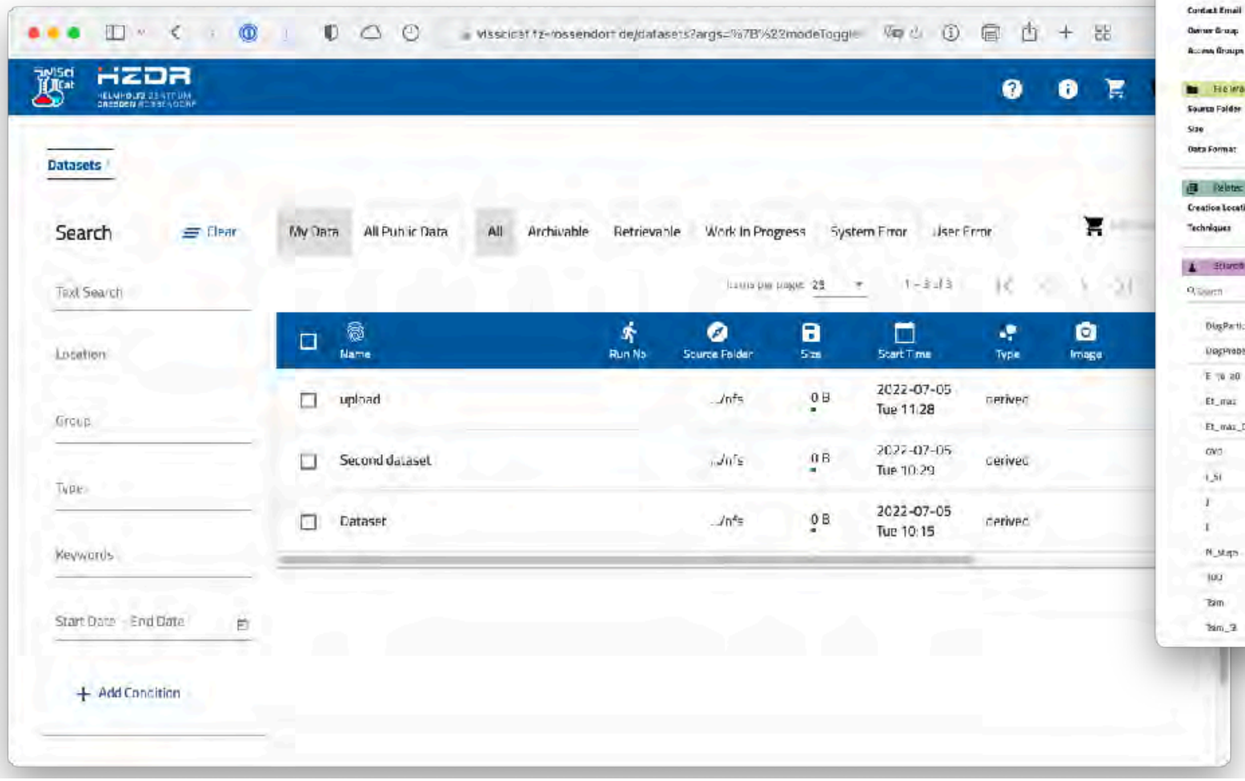
Automated data publication with:

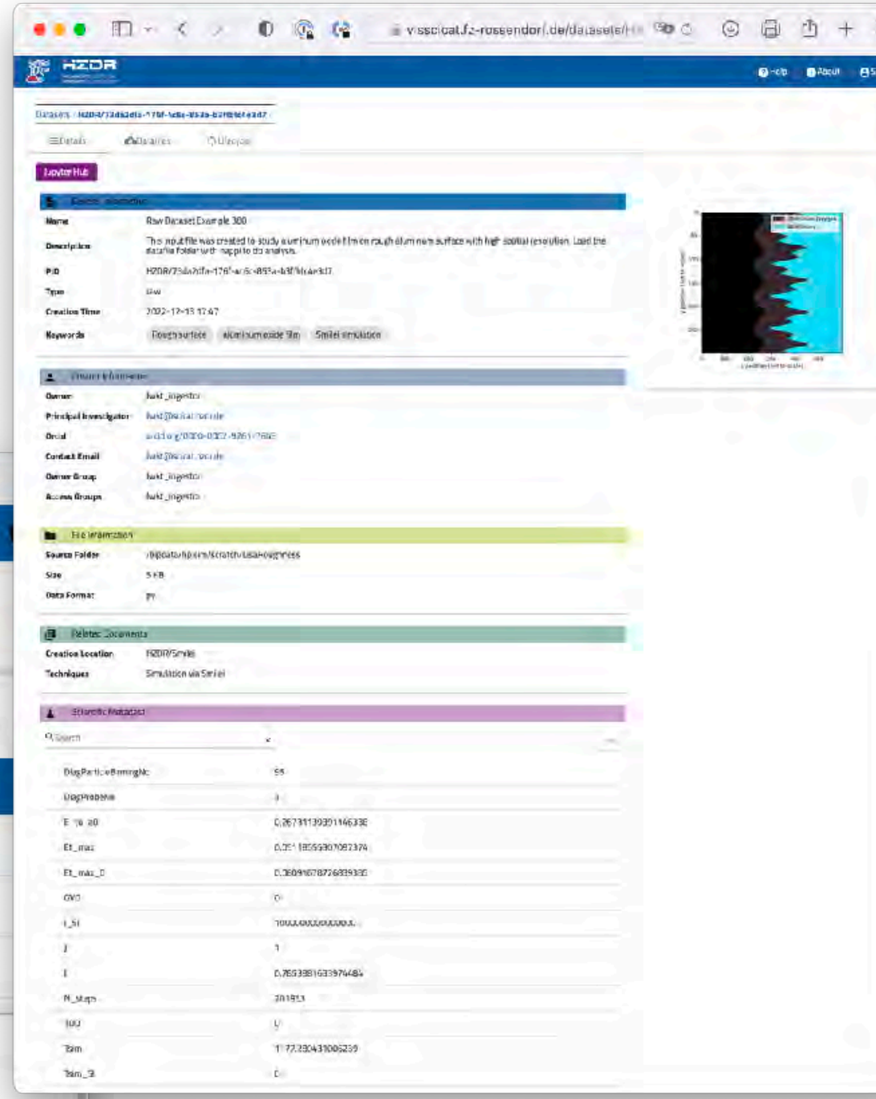
- Metadata from Proposal System,
- Files and folders registered and selected in HELIPORT.



VII. Search & Reuse: Metadata Catalogue SciCat

- With our data publication repository RODARE we provide a platform for publishing datasets.
- In RODARE, bibliographic metadata is based on **DataCite**.
- For additional **scientific metadata** we use SciCat and reference the specific datasets in RODARE or HELIPORT.

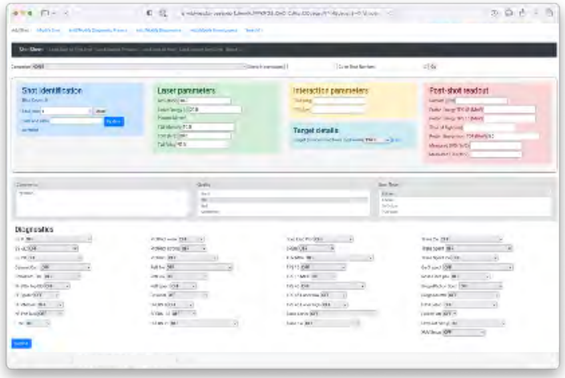




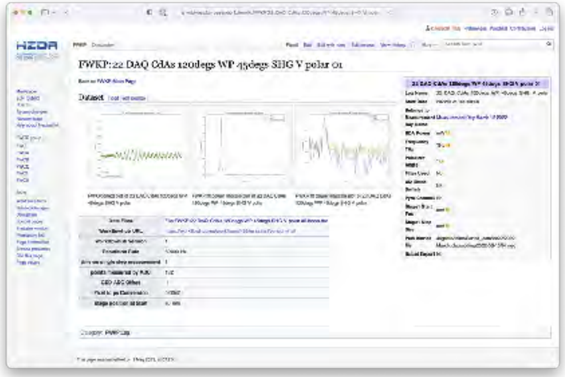
Metadata Catalogue SciCat and Data Repository RODARE (Draft)

Curated Metadata Source

ExperimentLogging app (ExL)



E-Logbook

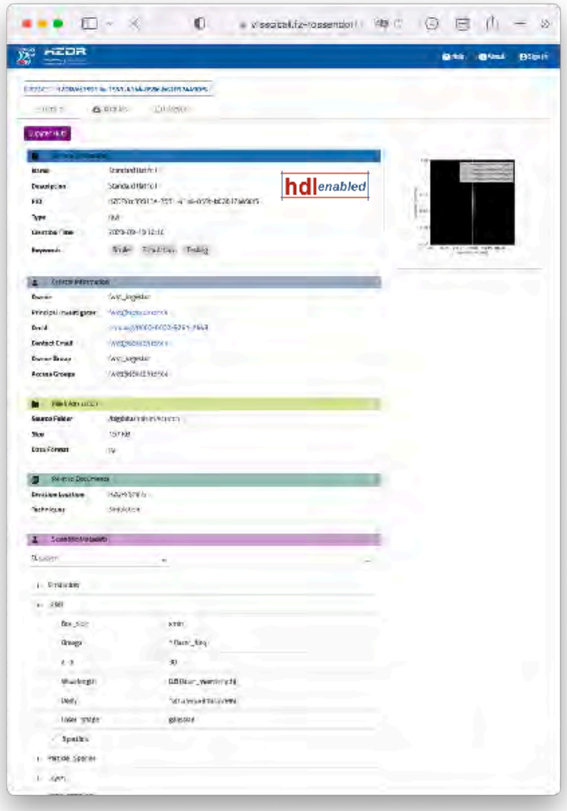


Metadata from Experiment/Simulation

Direct API Call

Public Metadata Catalogue

SciCat

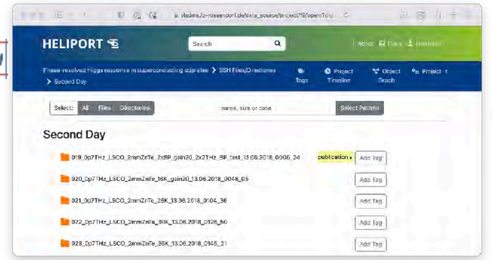


Data Access

RODARE

Dataset

HELIPORT



Filesystem

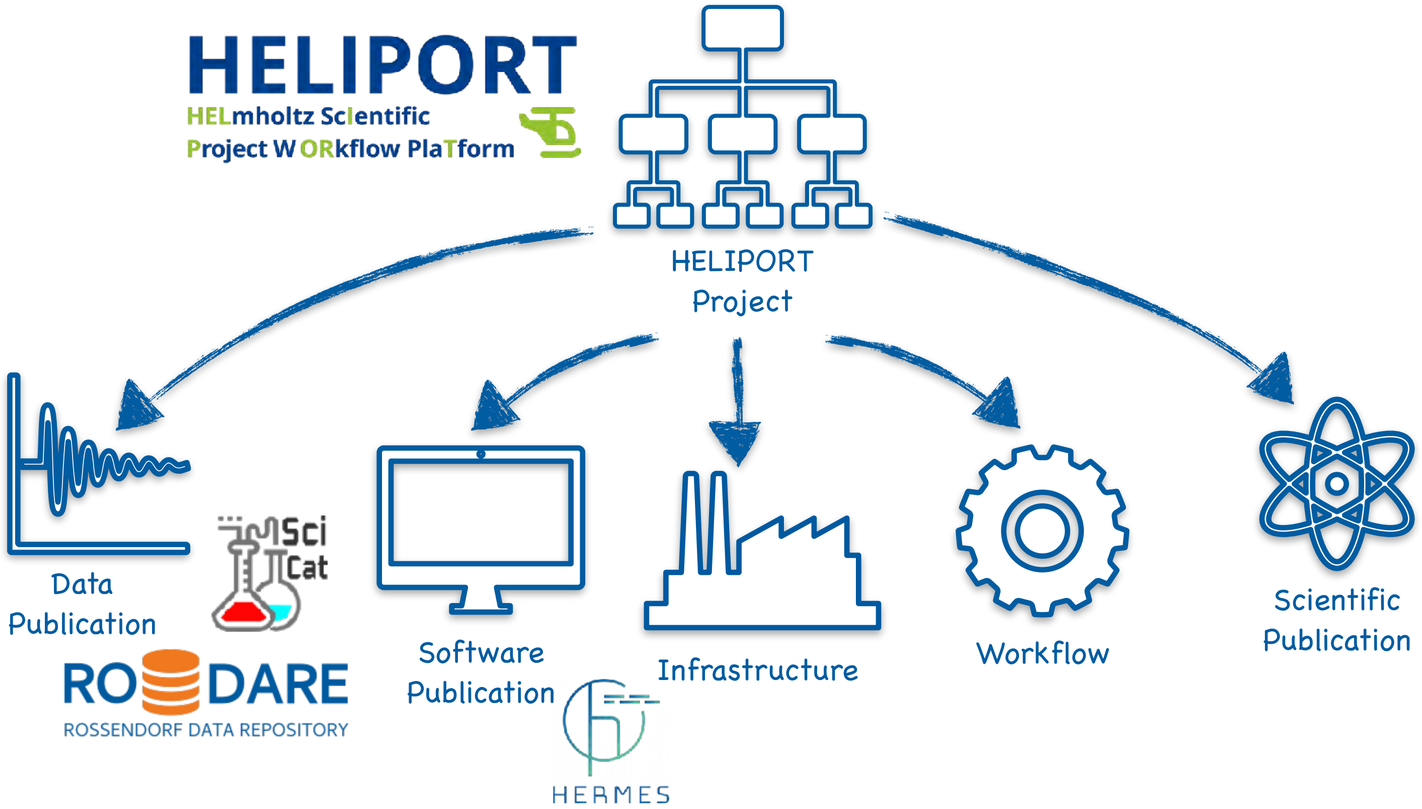
Tape Archive

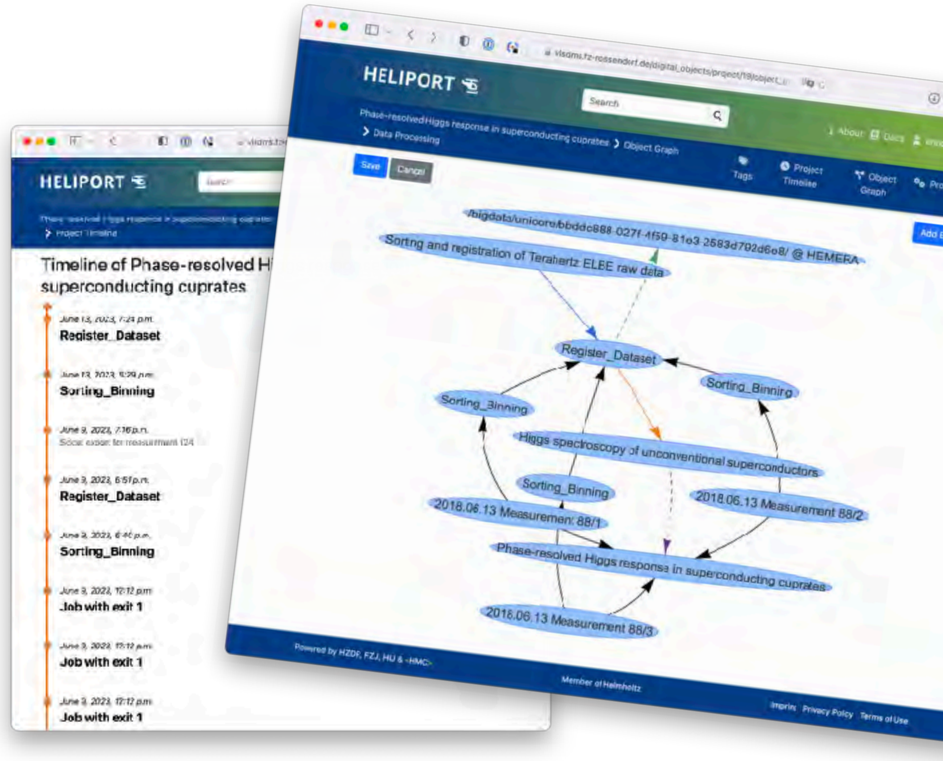
Conclusions

— Close and automated interaction of services and systems in our digital research landscape is essential to provide **FAIR** and **comprehensible** research projects.

— HELIPORT describes and **collects metadata** from services and systems involved in experiments.

— APIs and workflows are used to transfer metadata between our services and systems.

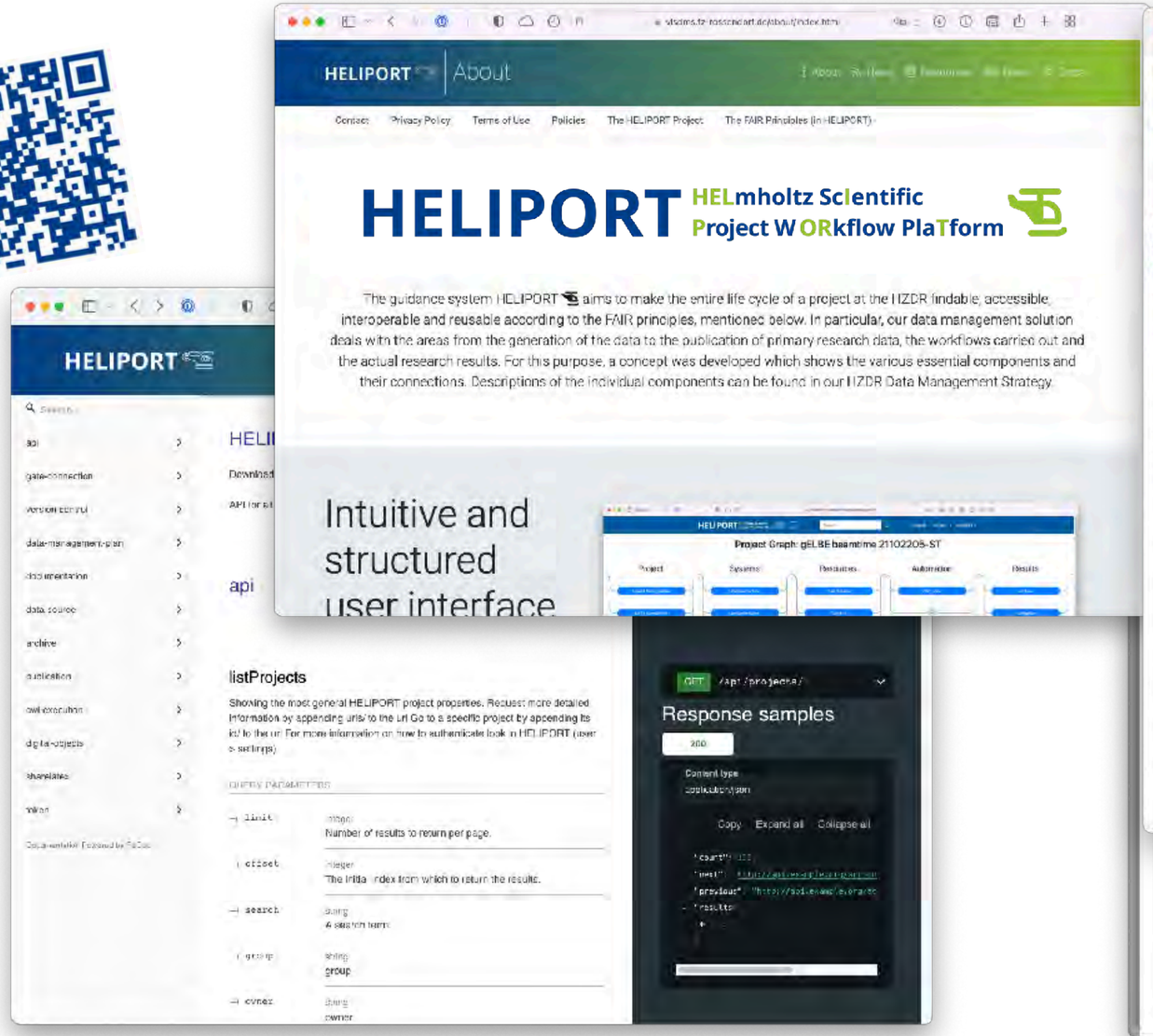




Resources

Website: heliport.hzdr.de

Repository: codebase.helmholtz.cloud/heliport

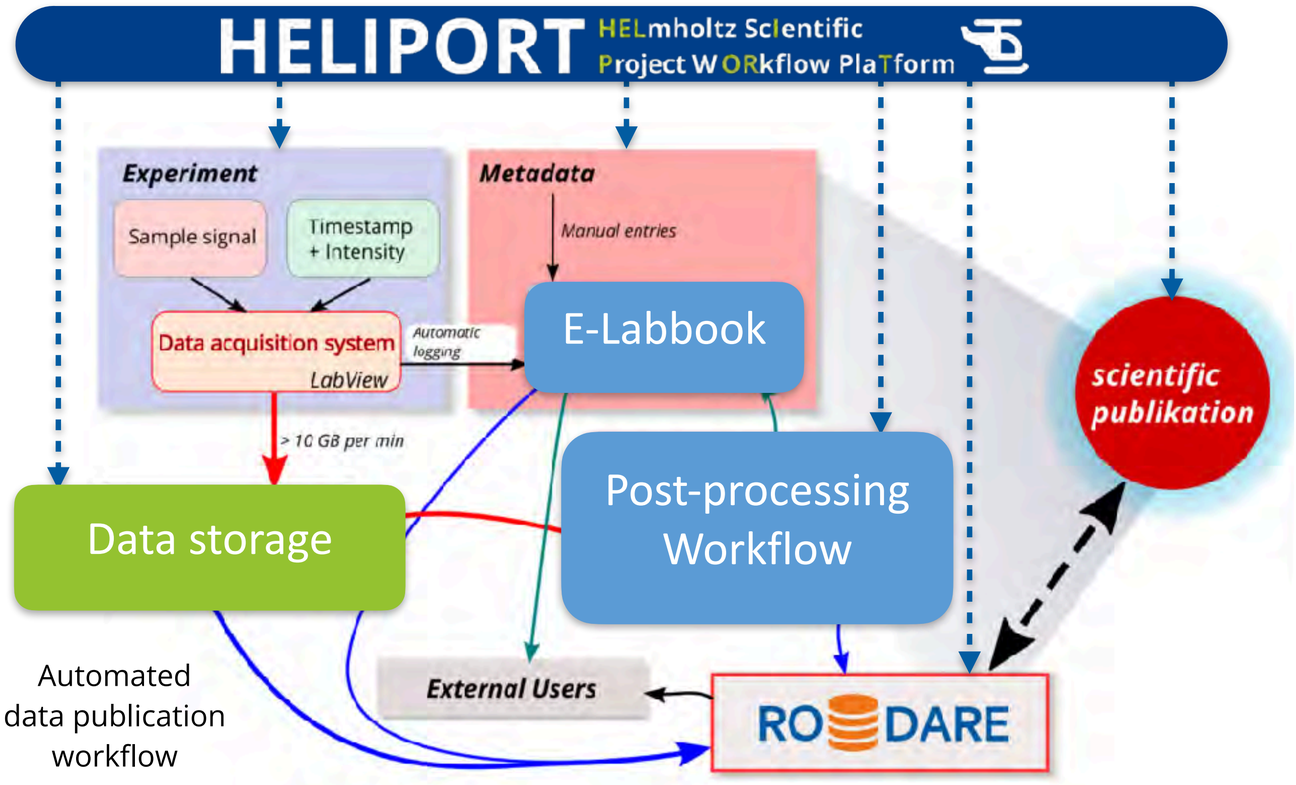


API Doc: heliport.hzdr.de/redoc/

Appendix

Example: Data Management View of the TELBE Experiment

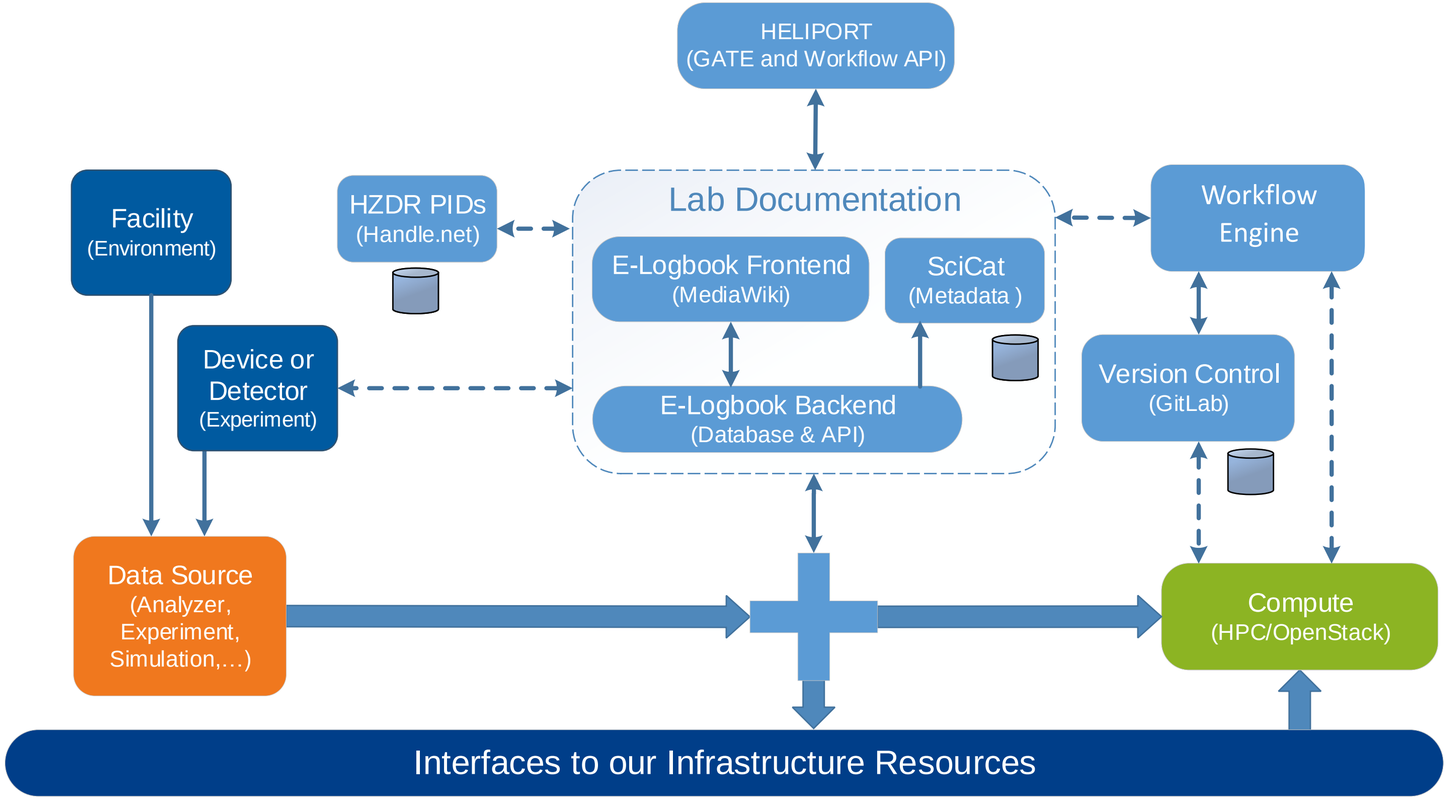
- Terahertz facility at the ELBE center for High-Power Radiation Sources.
- In the future HELIPORT guides (external) scientists through the complete experiment.
- Submission of data analysis Jobs from LabView to UNICORE with visualisation in HELIPORT.



Deinert, Jan-Christophi. (2021, November 18). TELBE data analysis workflow and the PaN training platform UX — Booklet of presentations from the PaN EOSC Symposium 2021. Zenodo. https://doi.org/10.5281/zenodo.5636331

Documentation Ecosystem at HZDR

— Our **Electronic Lab Documentation** is a central database gathering information from various systems:
  - Proposal management (GATE),
  - Environmental data,
  - Devices (e.g. Labview),
  - Workflows,
  - (Meta)data databases.
— Different frontends are available:
  - SciCat (metadata only),
  - MediaWiki (structured user-definable views).
— The system is build on-top:

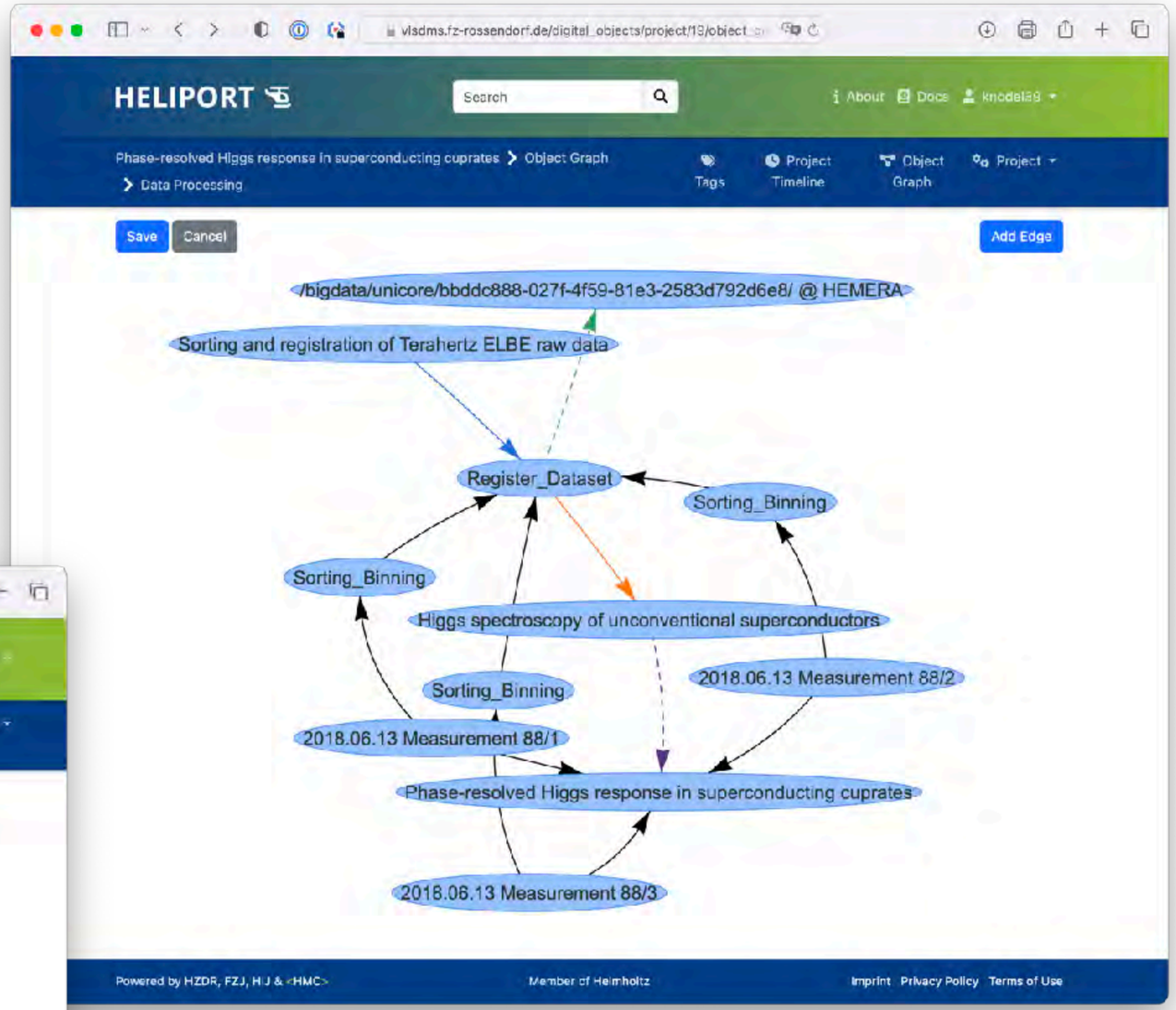


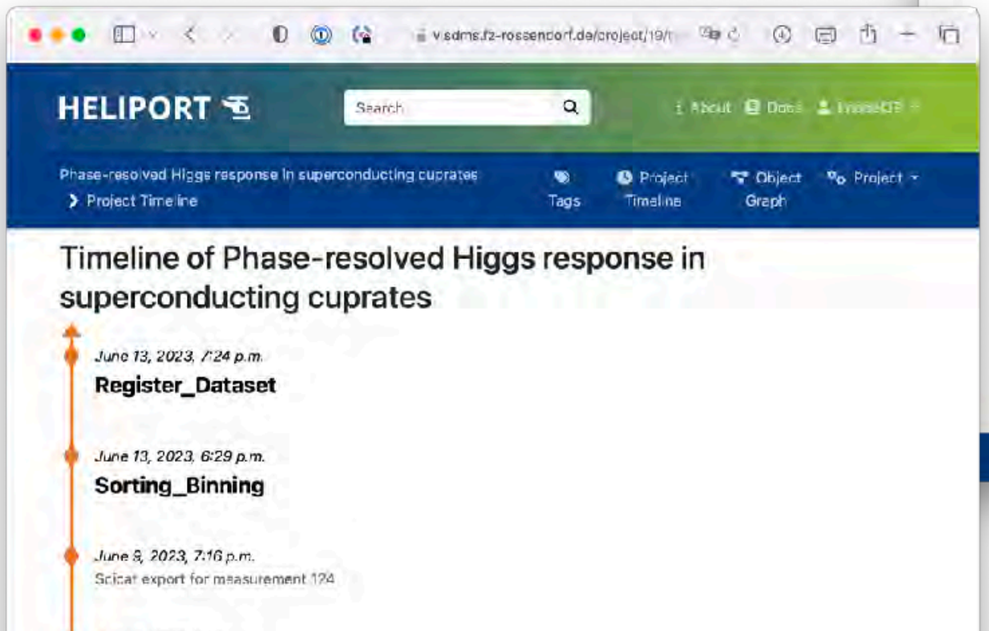
Relations Between Digital Objects and

— Relations between digital objects are visualized to provide a top-level view on the project with dependencies.

— The relationships between simulation (surrogate model) and experiment can also be demonstrated.

— The versioning of an experiment is an essential extension, and first approaches via a timeline are being evaluated.





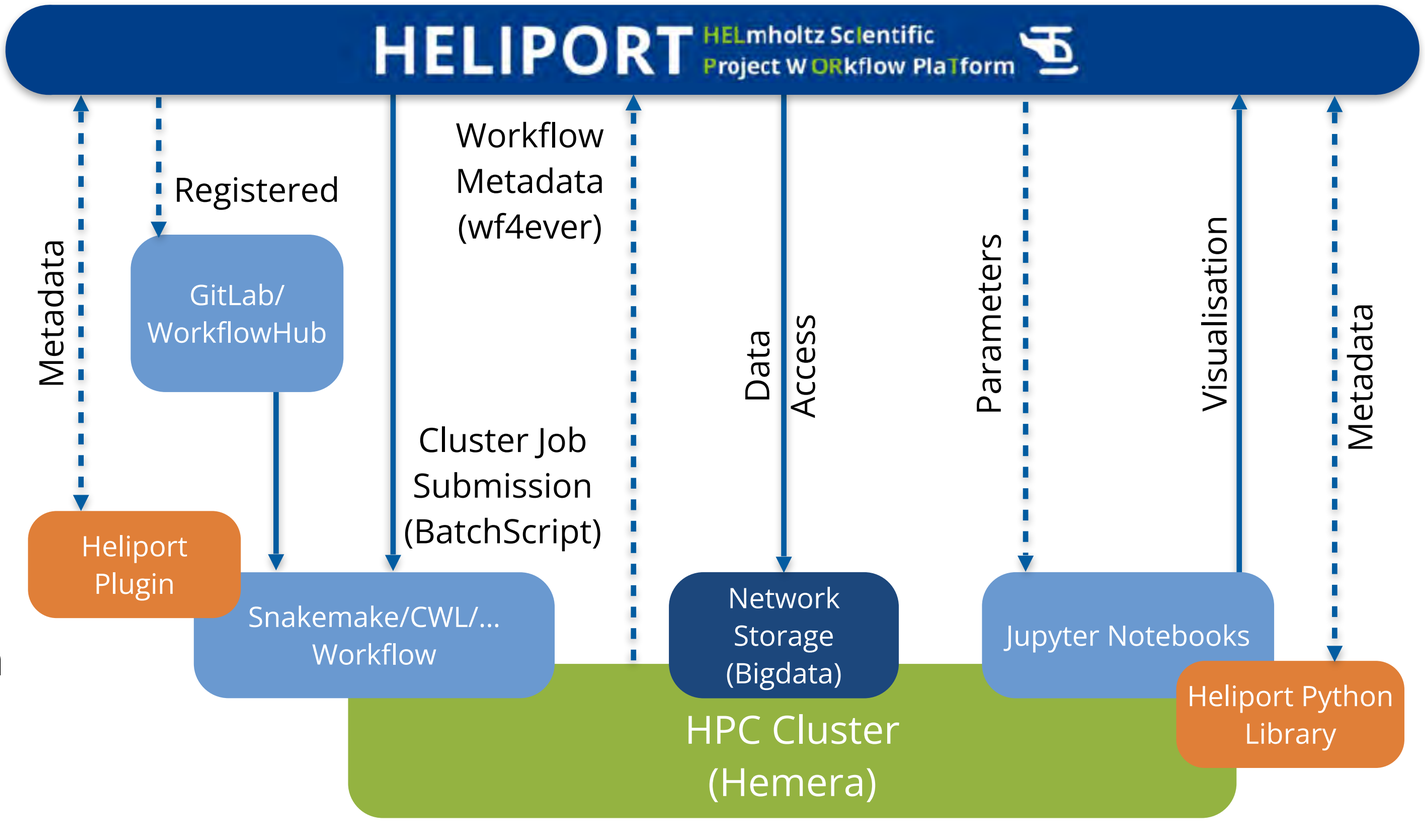
Workflow Architecture (in development)

— HELIPORT offers an infrastructure which permits the integration of various workflow languages and access modes to HPC infrastructures.

— The infrastructure keeps track of and collects the metadata and enables access to all resources involved.

— Next steps:

- Python library sending workflow information directly to HELIPORT,
- Provision of provenance information from Jupyter notebooks,
- Use case: **PIConGPU**



LabInfrastructure@Geo.X – A Search Portal for Laboratory Infrastructure

Helmholtz Open Science Forum
14th February 2024

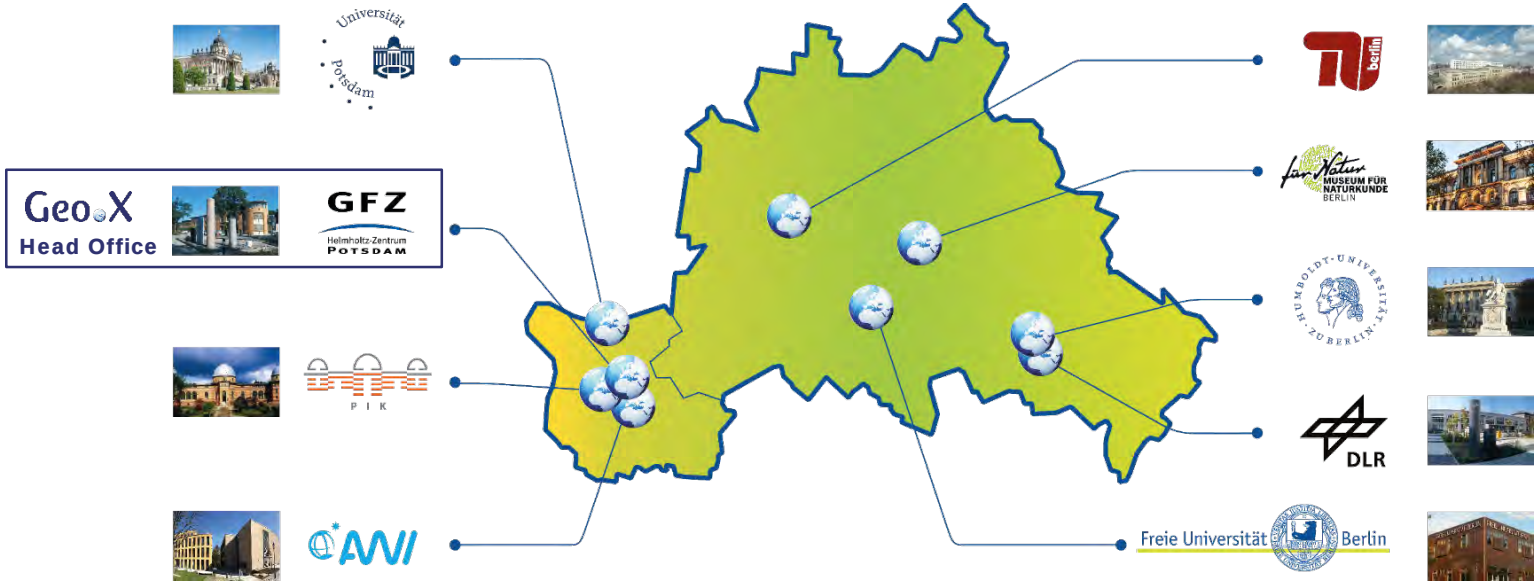
Manja Luzi-Helbing, Marc Hanisch, Hannes Fuchs, Hildegard Gödde*

LabInfrastructure@Geo.X – Service for Laboratory Infrastructure Search

- **DataHub** service
  (Laboratory Infrastructure Inventory LI2)
- Joint and comprehensive laboratory infrastructure portfolio
- Role-based curation of information about laboratories, instruments, methods and more
  → information available via search portal
- Concept is compatible with multiple institutional or network environments within Helmholtz and beyond
- Customized to the needs of the Geo.X network as **LabInfrastructure@Geo.X**

https://datahub.erde-und-umwelt.de/en/tools-and-services

Geo.X Research Network for Geosciences in Berlin and Potsdam

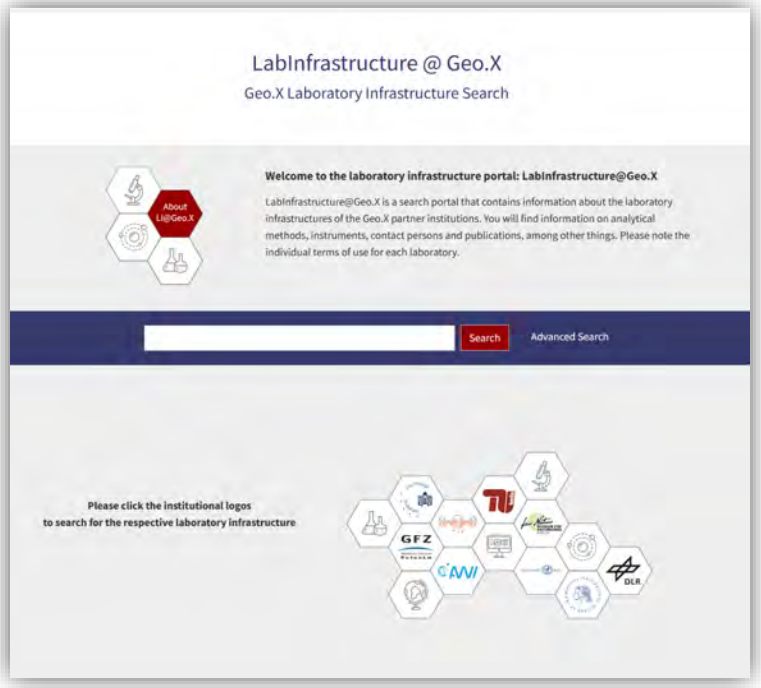


- Search portal for the laboratory infrastructure within the network: **LabInfrastructure@Geo.X**

LabInfrastructure@Geo.X - A Laboratory Infrastructure Search Portal for the Geo.X Network

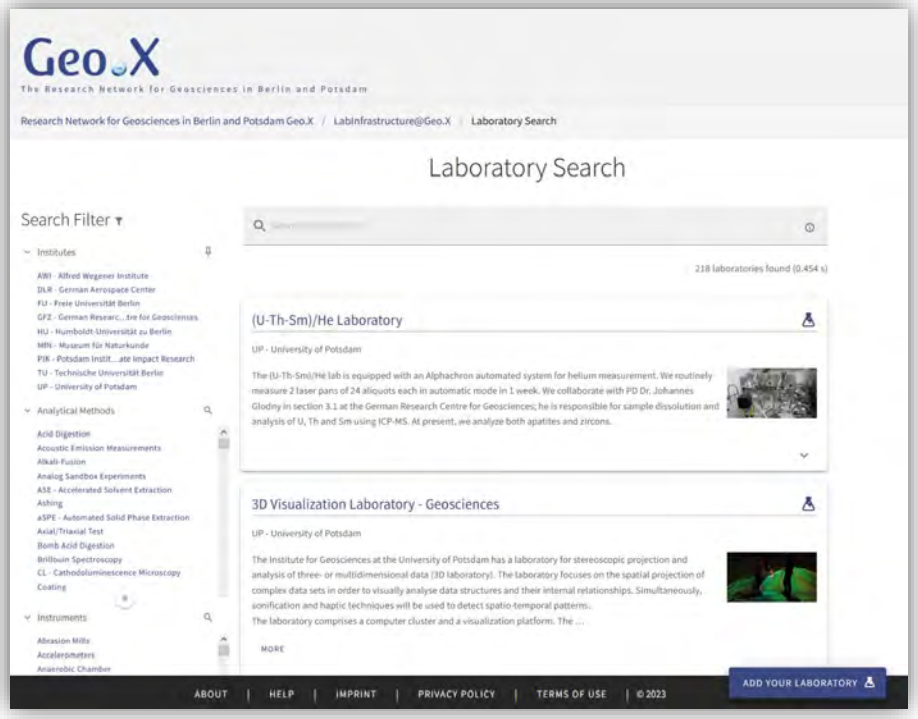
- Participation of all nine Geo.X partner institutions
- Currently ca. 220 entries for laboratories, further inquiries in progress
- Tagging from over 250 analytical methods / instruments
- First start in May 2020, relaunch as DataHub service in July 2023

Scan me



https://www.geo-x.net/geox-laboratory-infrastructure-search/

LabInfrastructure@Geo.X – Laboratory Search

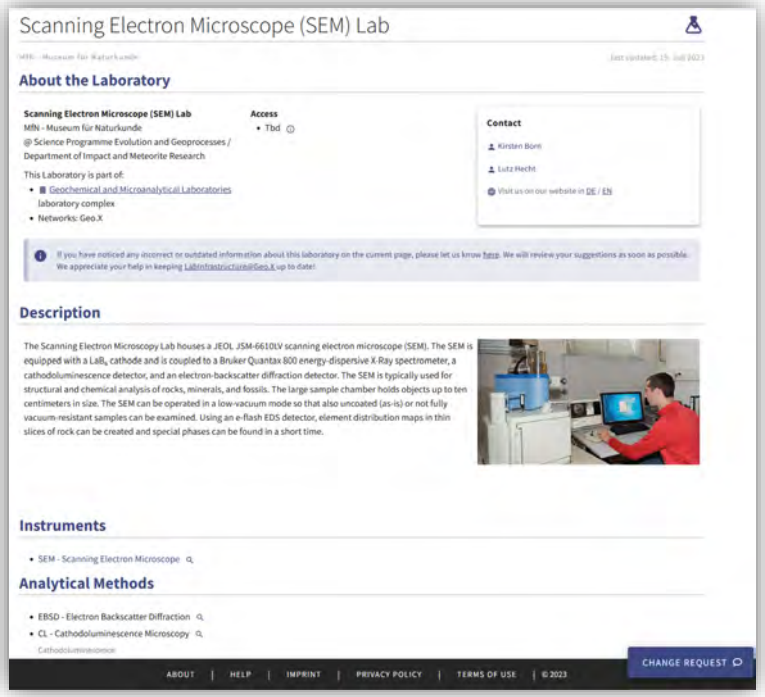


https://labinfrastructure.geo-x.net/laboratories/

Semantic search options and extended filter functions

- Filter by institutes, instruments, methods etc.
- Search for keywords
- Use search operators to combine or exclude keywords

LabInfrastructure@Geo.X – Laboratory Details and Change Request

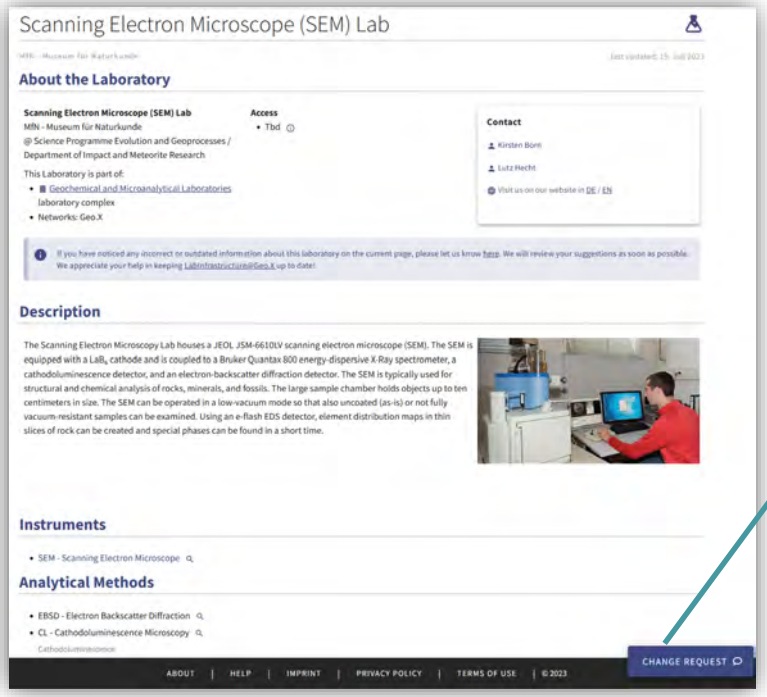


https://labinfrastructure.geo-x.net/laboratories/105

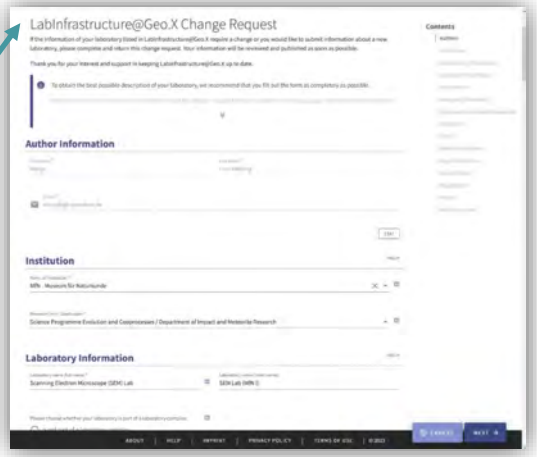
Lab Detail Page

- Brief description of the laboratory
- Instrument and analytical method (using a defined vocabulary)
- Contact details of laboratory supervisor(s)
- Laboratory location (institution)
- Link to original laboratory websites
- Key and data publications
- Information on user access to laboratories and user regulations if available

LabInfrastructure@Geo.X – Laboratory Details and Change Request



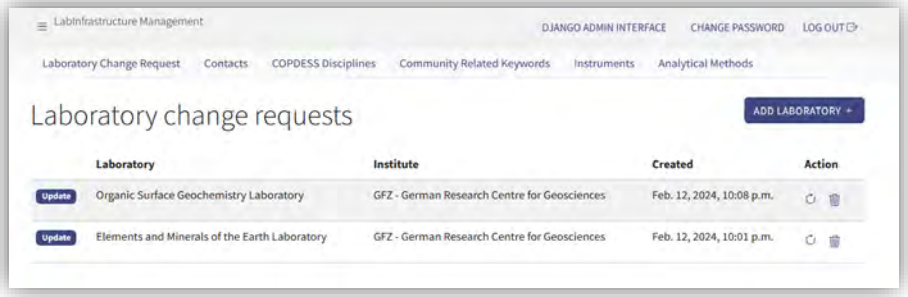
https://labinfrastructure.geo-x.net/laboratories/105

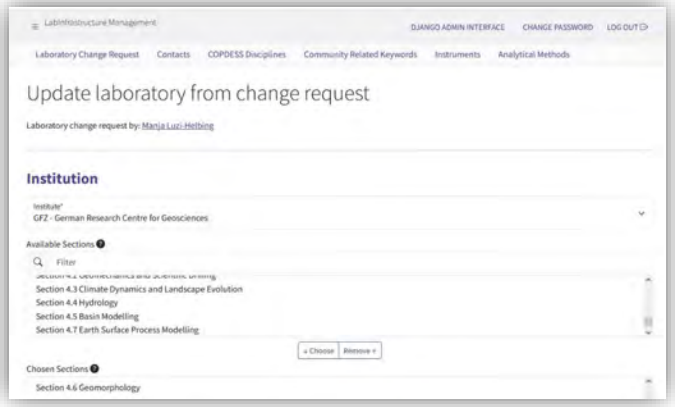


Web-based user interface to submit new and modified records

- User-friendly form for change requests
- Searchable vocabulary
- Integrated help system

LabInfrastructure@Geo.X – Management Interface for Curation





Decentral editing and curation of laboratory's metadata

- Feature-rich editor for curators
- Review of the change request with existing metadata
- Approval process

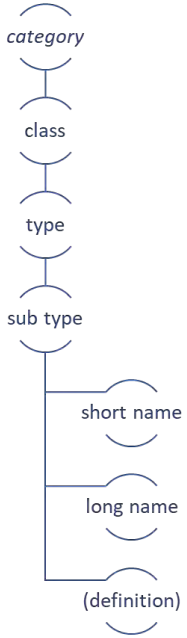
LabInfrastructure@Geo.X – Vocabulary

Advanced vocabulary for instruments and analytical methods aligned with international standards

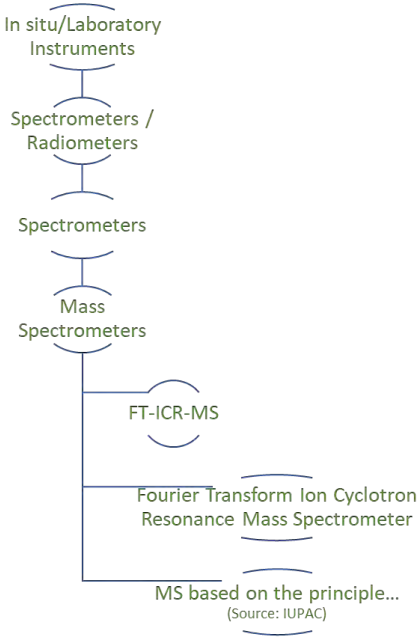
- Based on the NASA GCMD instrument keywords
- Easy to update, customize and expand
- Browseable by categories

LabInfrastructure@Geo.X – Vocabulary

- **Four-level keyword structure** for the Geo.X keywords as well as a short name/long name + definition for the instruments and analytical methods
- Adapted from NASA GCMD instrument / sensor keyword structure
- Choice between **Geo.X vocabulary** and **NASA GCMD instrument keywords**



NASA instrument / sensor keyword structure



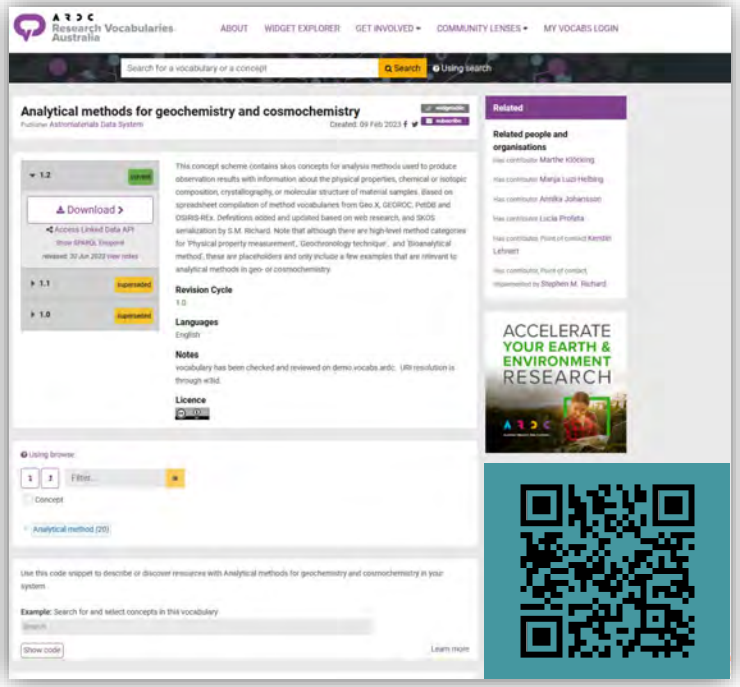
Adapted hierarchical structure based on an example for Geo.X instrument keyword

Reference: Global Change Master Directory (GCMD). 2023. GCMD Keywords, Version 16.5, Greenbelt, MD: Earth Science Data and Information System, Earth Science Projects Division, Goddard Space Flight Center (GSFC), National Aeronautics and Space Administration (NASA). URL (GCMD Keyword Forum Page): https://forum.earthdata.nasa.gov/app.php/tag/GCMD+Keywords

LabInfrastructure@Geo.X – Vocabulary

- Vocabulary for analytical methods in geo- and cosmochemistry

Research Vocabularies Australia



https://vocabs.ardc.edu.au/viewById/650

Interaction with other Services and Projects: Digital Research Ecosystem at GFZ

GFZ infrastructure

- Compact overview over laboratory infrastructure
- 105 laboratories and laboratory complexes
- Filter on MESI (Modular Earth Science Infrastructure) and Large Infrastructures LI

LI2

Joint vocabulary for labs

Link to data publications

https://labinfrastructure.geo-x.net/laboratories/8

Detailed information on instruments

Information on laboratories, methods, controlled vocabularies

Sensor Management System

ALAMEDA

<HMC> HELMHOLTZ METADATA COLLABORATION

Interaction with National and International Initiatives

NFDI4Earth

Part of the NFDI$_4$Earth infrastructure

Open for Exchange & Collaboration

...

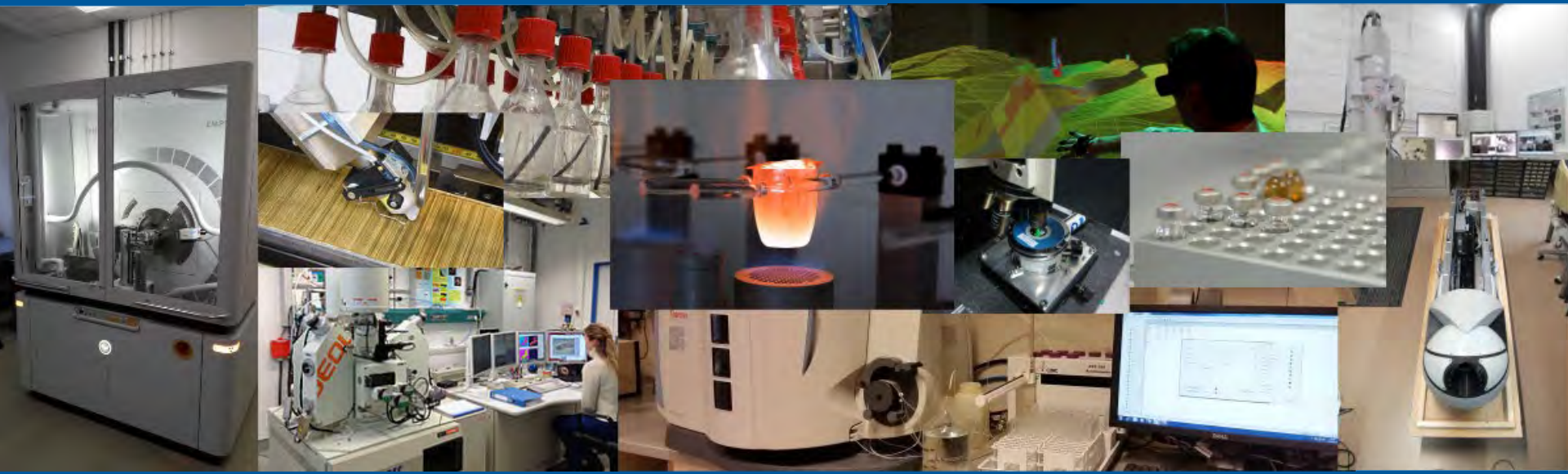
Support & Collaboration

Exchange

OneGeochemistry Initiative

EPOS Multi-Scale Laboratories

Thank you!



mluzi@gfz-potsdam.de

The Open Infrastructure Portal for DESY and HIFIS

Tim Wetzel & Patrick Fuhrmann
Hamburg, 14.04.2024

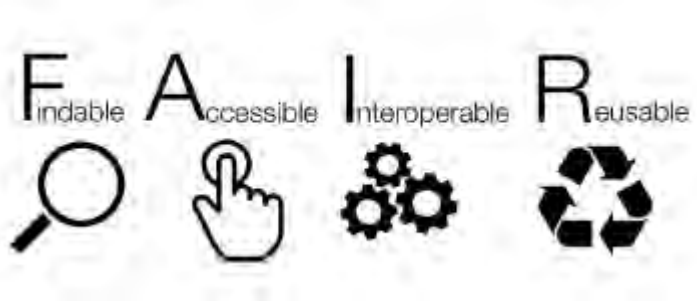
HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

DESY.

Open and FAIR data for Photon Science in DESY

The motivation for a prototype system

FAIR data will become the standard



- Funding bodies and journals demand data to be open and/or FAIR
  - Public money = public data (after embargo period)
  - Supplemental data for publications
- Combatting the reproducibility crisis in science
- Reusability makes for a more sustainable (re-)use of results obtained from costly and laboriuos experiments

Starting with Photon Science

- As one of the largest photon science laboratories in Europe, DESY will start providing a standardized way to host Open and FAIR data for her scientists

Why FAIR?

- Not only for verifiable & reproducible scientific results (as enforced by many journals)
- Machine readability for e.g. ML & AI

The minimum viable system for DESY.

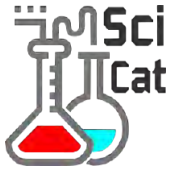
Essential components with federated access (authenticated & non-authenticated)

1st phase

Long term storage (dCache via hifis-storage.desy.de**)**

- accessible via standard protocols (https, NFS, WebDAV)

Metadata Catalogue with



- mandatory core metadata fields
- optional domain specific metadata fields
- OAI-MPH protocol for data harvesting of core metadata by high level catalogues

2nd phase

DOI Minting Service

- In cooperation with our library

Open Science (Virtual Research) infrastructure

- VISA portal, currently working on it together with other synchrotron facilities in Europe under an MoU

How we interpret Open and FAIR data

Open data by itself is of no value unless it fulfills certain quality criteria

- Since 2014 these criteria are known as FAIR data principles
- FAIR ≠ Open: FAIR just defines attributes and level of reusability, openness is not a requirement
  - Providing access can be a matter of resources, licenses, embargo times, …
- One of 1000s of definitions for FAIR: Cambridge Crystallographic Data Center
  - “The FAIR Data Principles set out criteria that enable the philosophy of openness to be realized in a tangible way through modern publishing practices and infrastructures that support current data science needs.”
- Open data enriched by metadata, context and provenance allows for better understanding and makes it more valuable

Importance of proper metadata definitions

Consensus and standards are key

Mandatory core metadata fields

- Defined in prior activities and by responsible reference bodies
  - e.g. Dublin Core, DataCite v4.4

Optional domain specific metadata fields

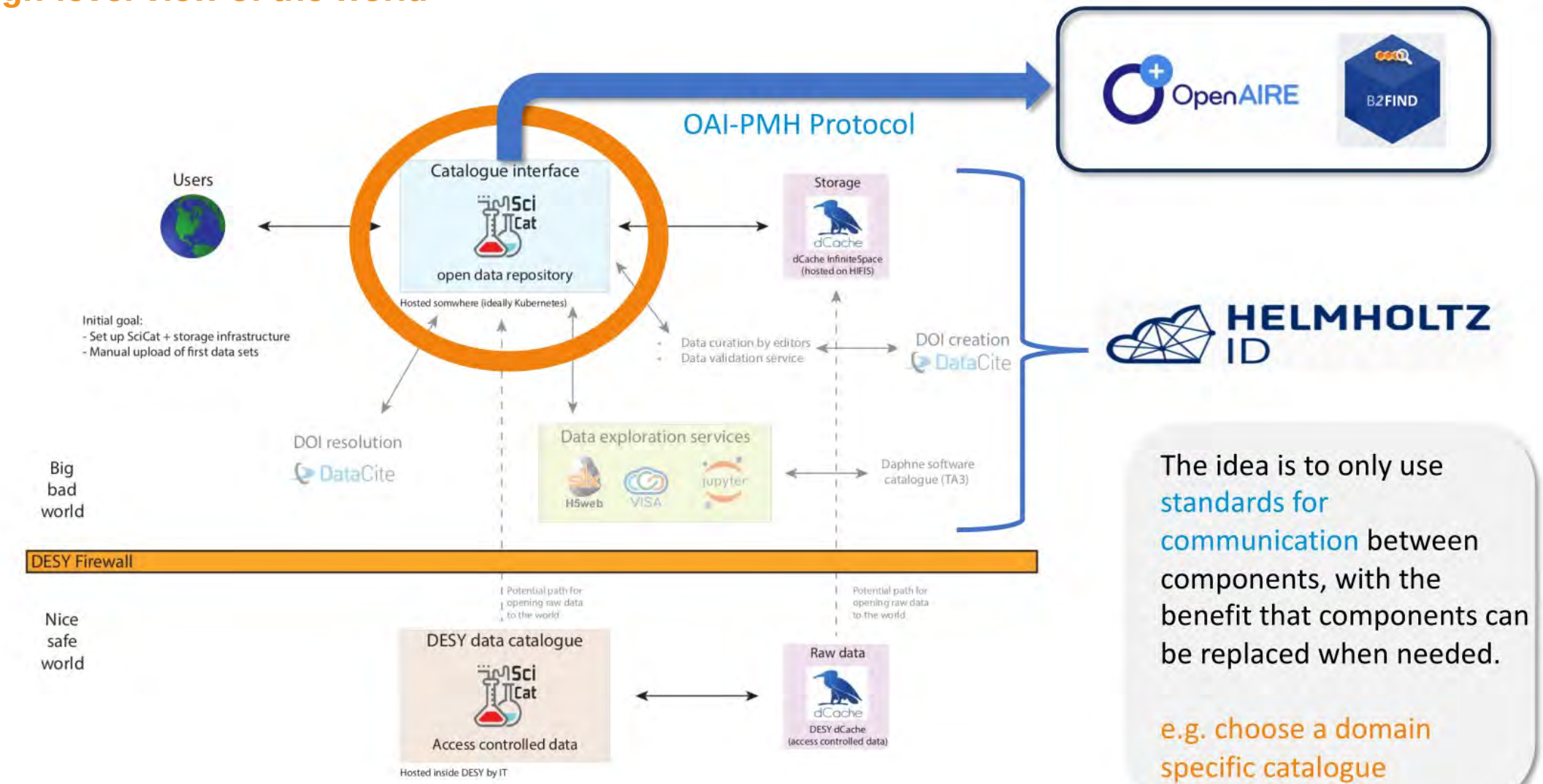
- Need to be provided by the specific communities
  - e.g. former ExPaNDS/PaNOSC, DAPHNE4NFDI, Photon Science Community

In parallel to Open Metadata

- Additional specific information might be required at
  - Beamline level
  - Facility level

Photon Science setup

A high-level view of the world

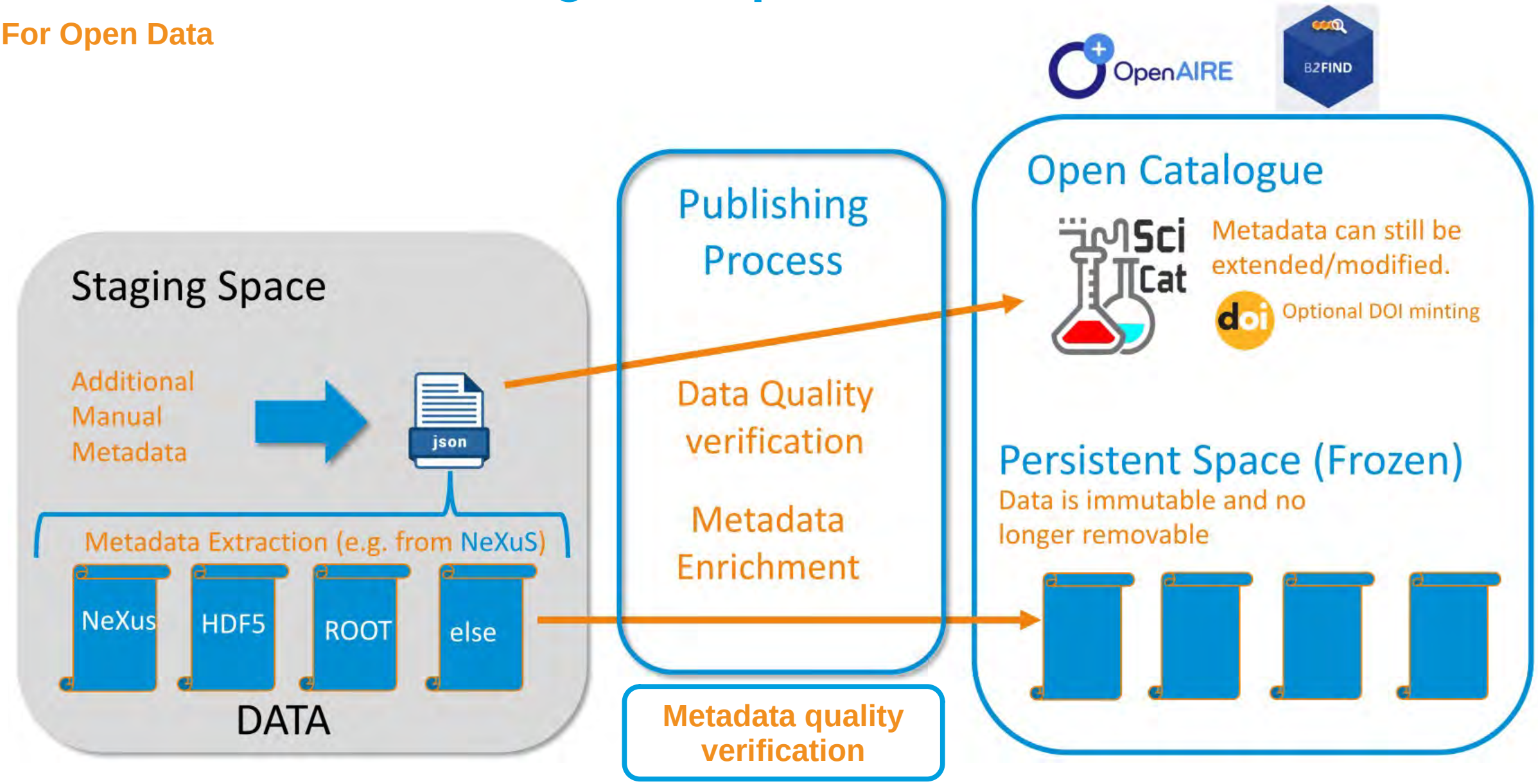


The idea is to only use standards for communication between components, with the benefit that components can be replaced when needed.

e.g. choose a domain specific catalogue

Our envisioned data ingestion process

For Open Data



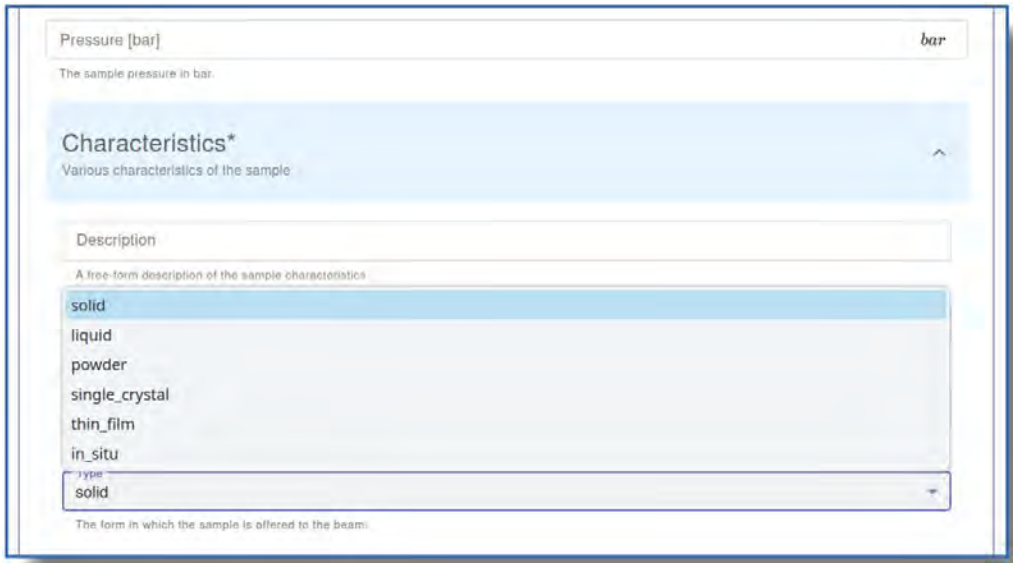
Our envisioned data ingestion process

Metadata quality verification

- First installment with LinkML
  - https://gitlab.desy.de/ric/opendata-metadata/
  - Metadata schema description via YAML documents setting standards that metadata has to conform to
  - Data description in terms of “classes” and “slots”, allowing inheritance and mixins for creating custom types
  - 60+ different open-source tools to work with schemata for introspection, validation, format conversion, …

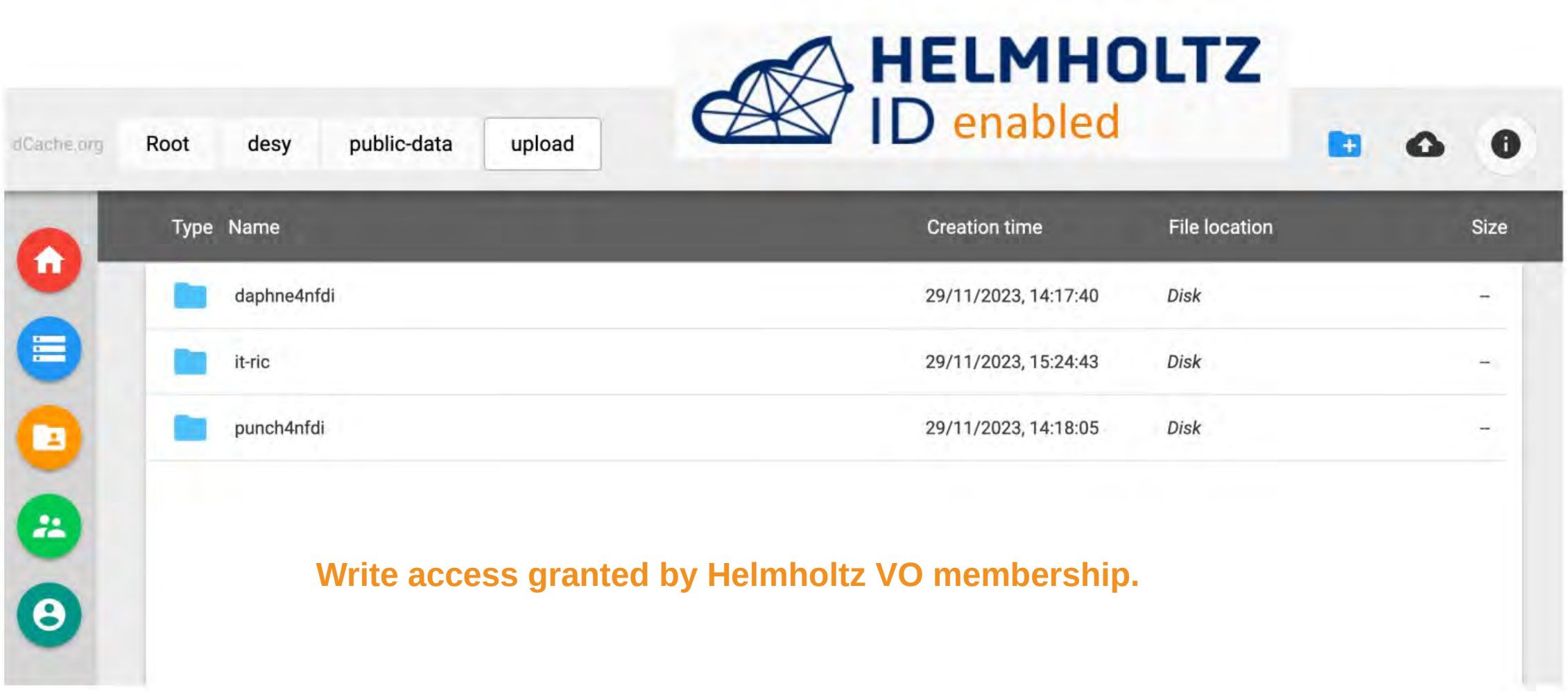
- Starting with two public data use-cases
  - XAS & SFX
  - Integration into Gitlab CI/CD pipeline for linting, generating documentation and JSON-Schema

- If you are interested in details:
  - Let me know and I can get you into contact with my colleagues



hifis-storage.desy.de

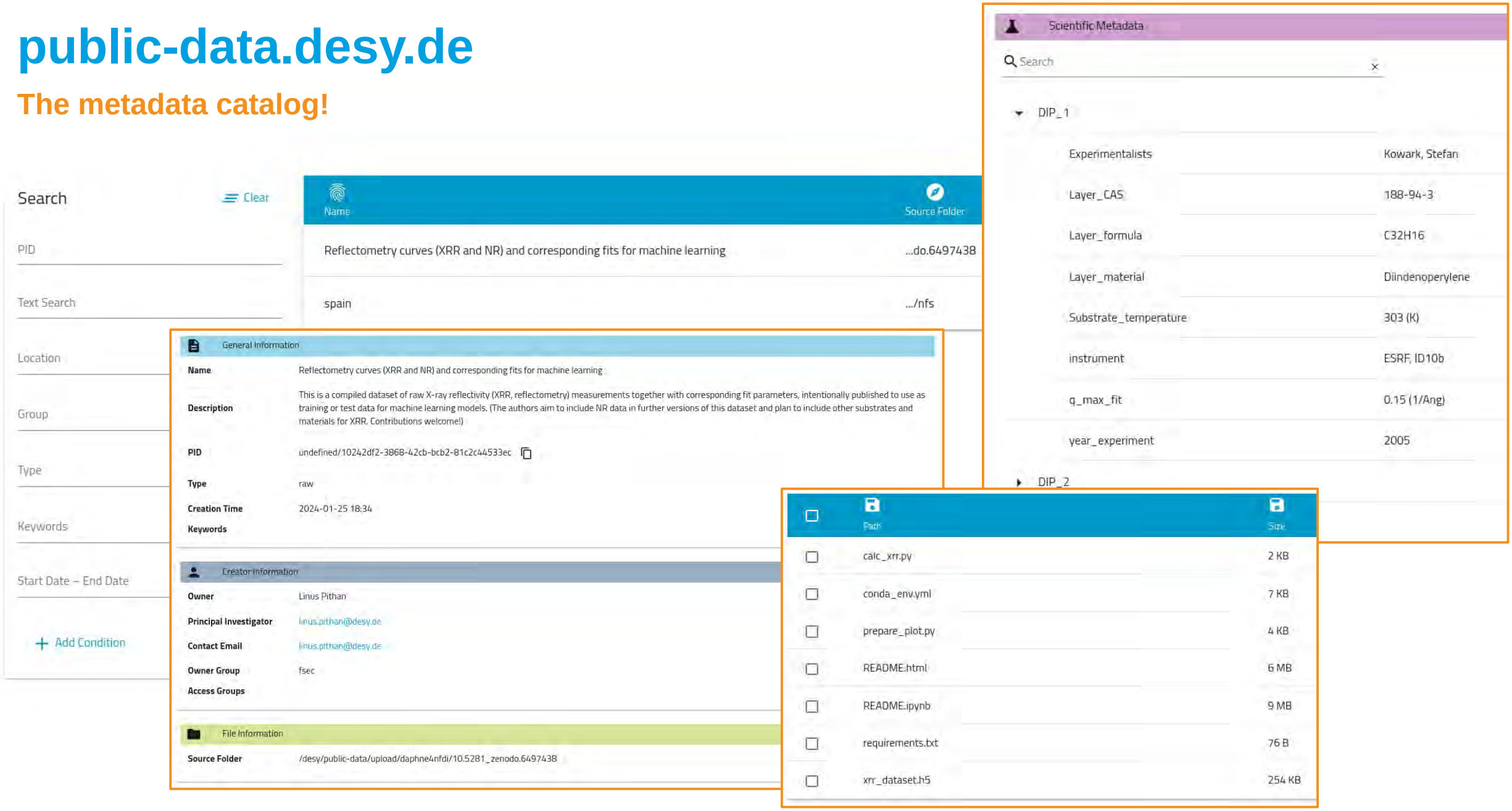
The “drop box” and and final storage space for Open Data



Write access granted by Helmholtz VO membership.

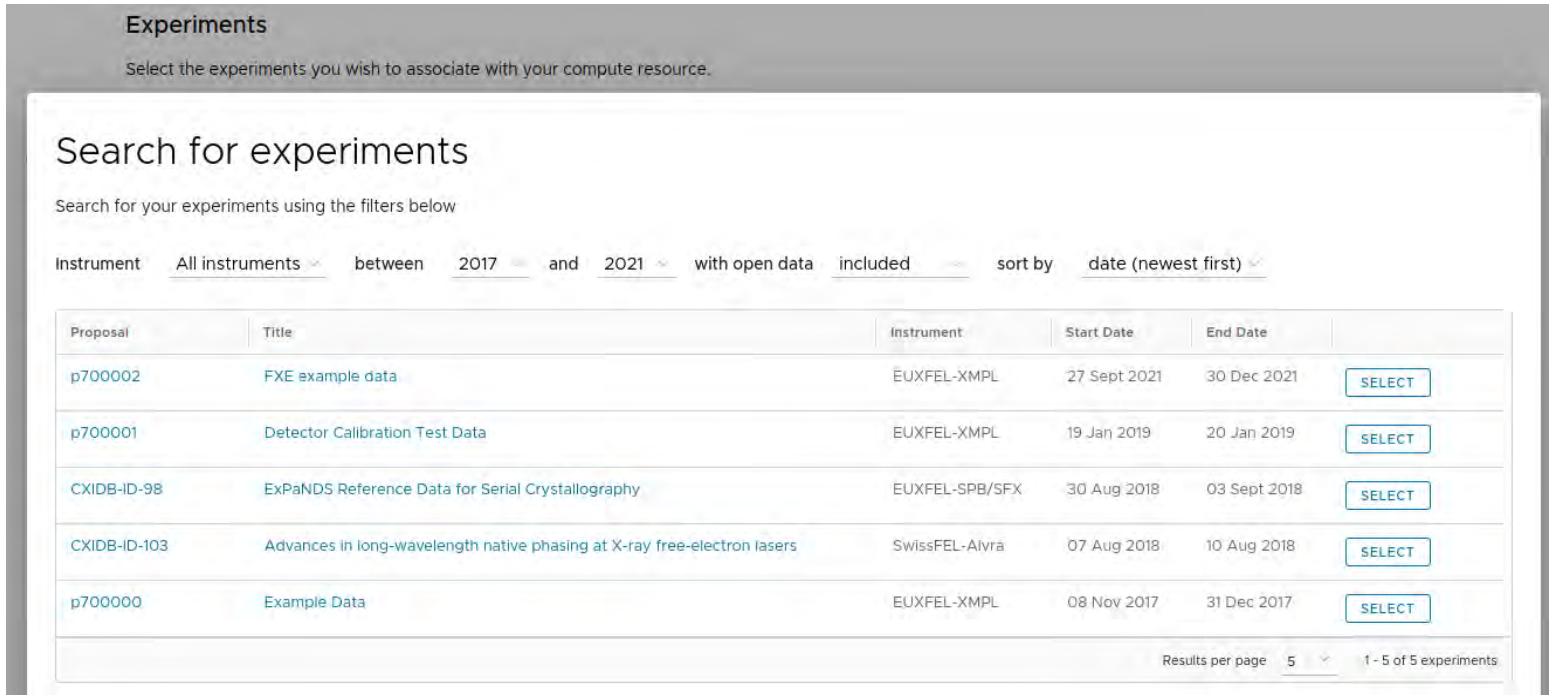
public-data.desy.de

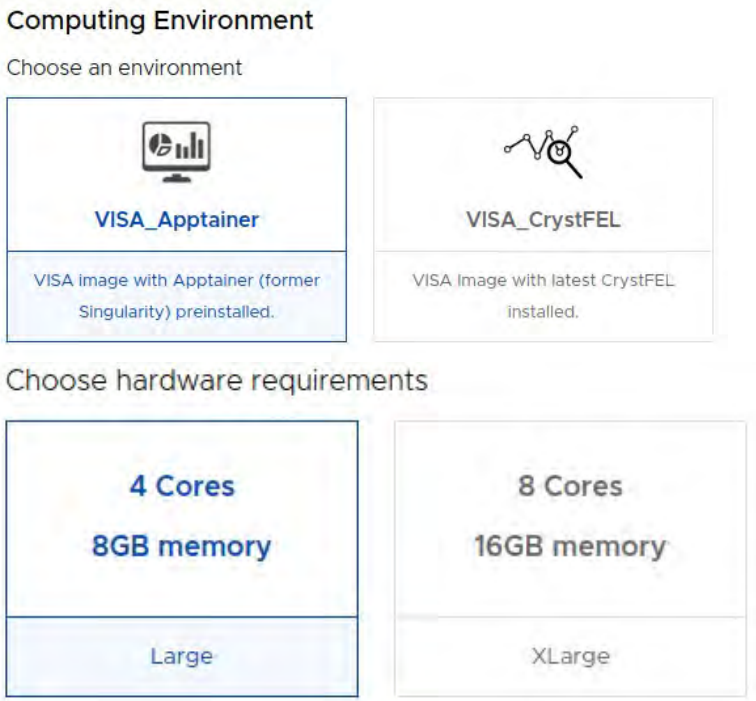
The metadata catalog!



visa.desy.de

Select a dataset to spawn a virtual machine





VISA database currently populated with example datasets.

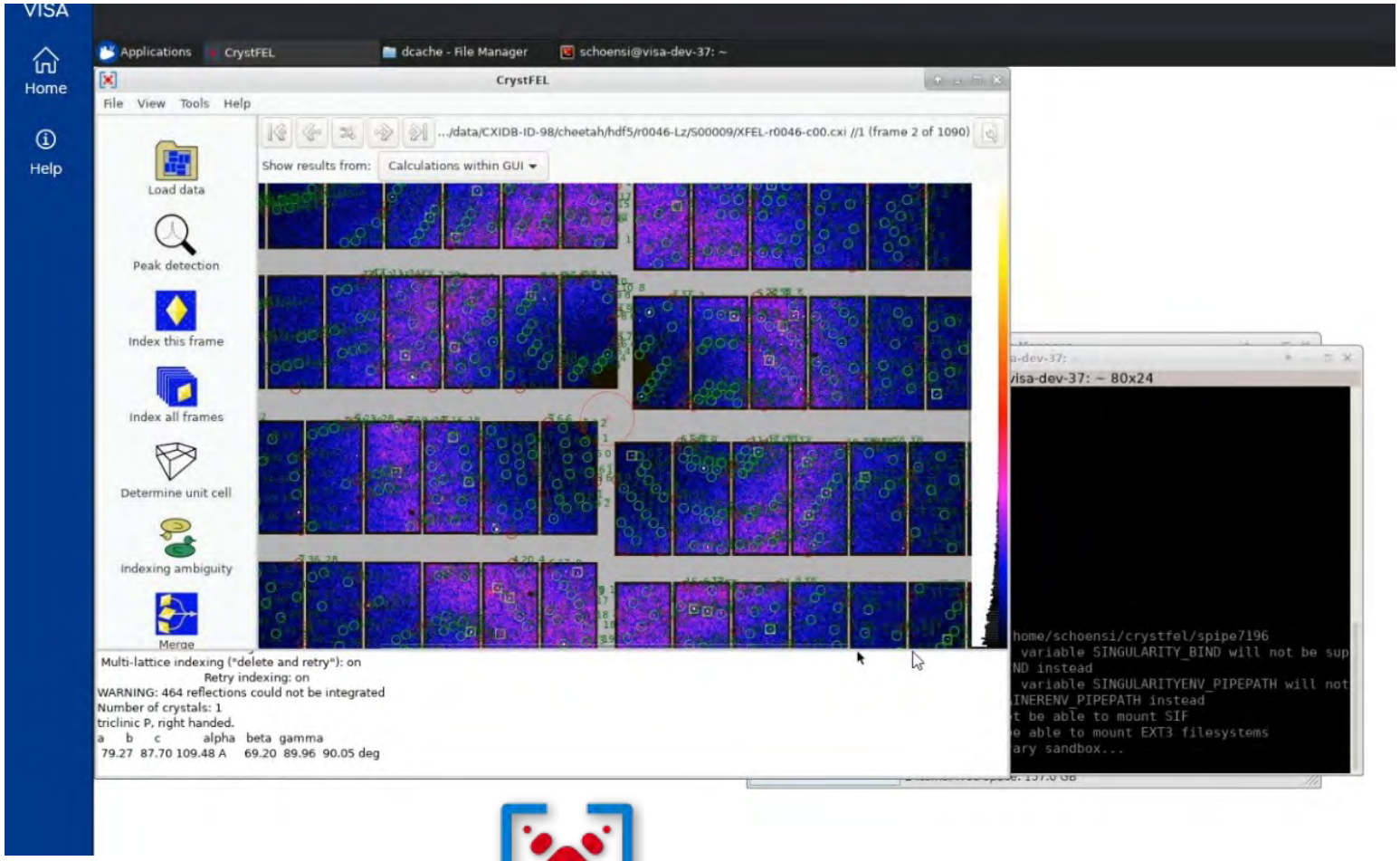
Open Data to be integrated during 2024 via automated data export from public-data.desy.de

visa.desy.de

Work via remote desktop connection with graphical interfaces

Using CrystFEL Docker Images to run Singularity Container and work with Crystfel 10 Graphical Interface.

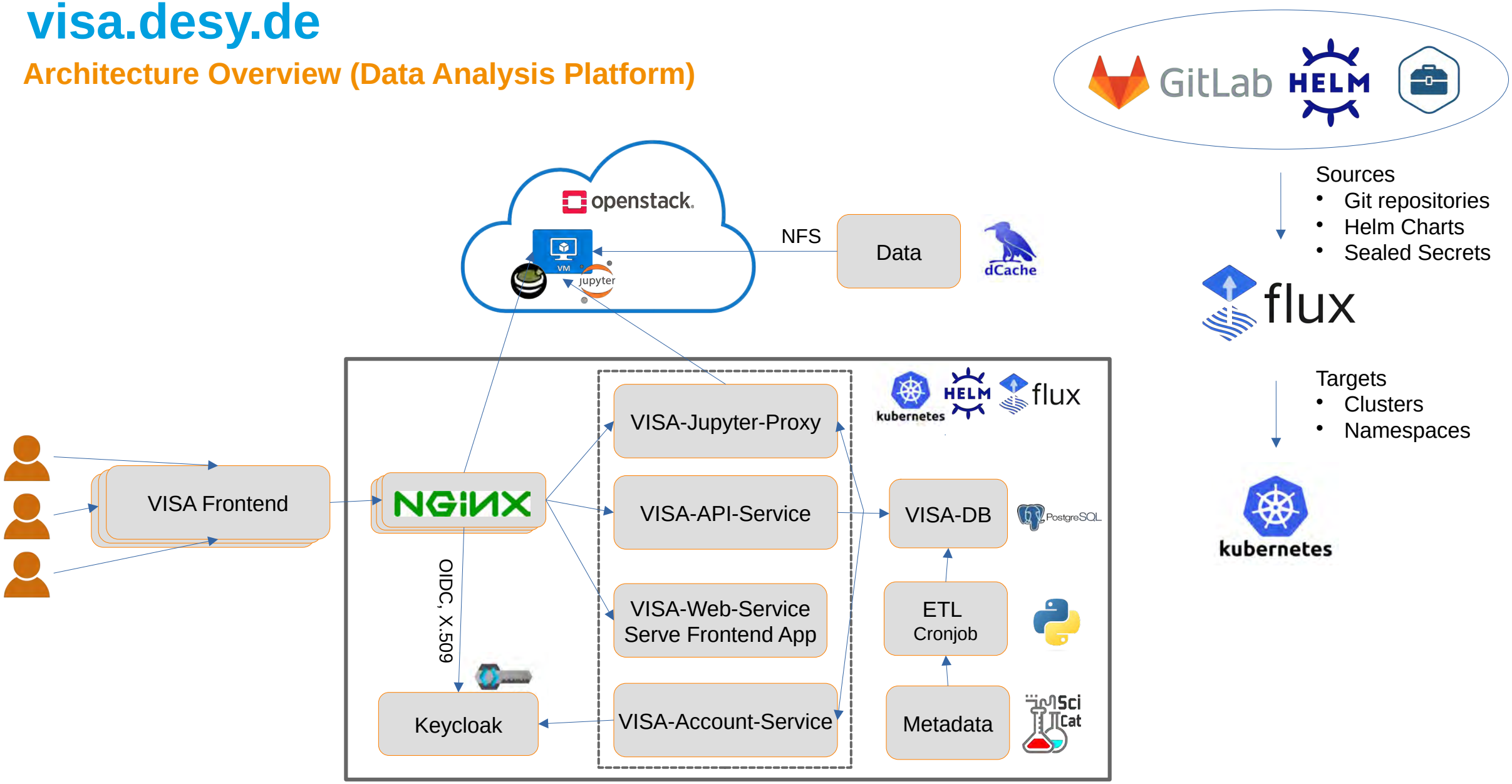
Example by Silvan Schön (DESY/FS-SC)



CrystFEL

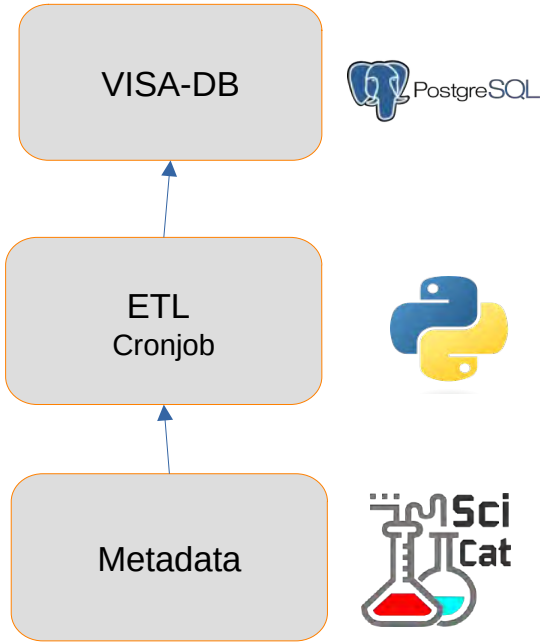
visa.desy.de

Architecture Overview (Data Analysis Platform)



visa.desy.de

Metadata import via custom ETL process



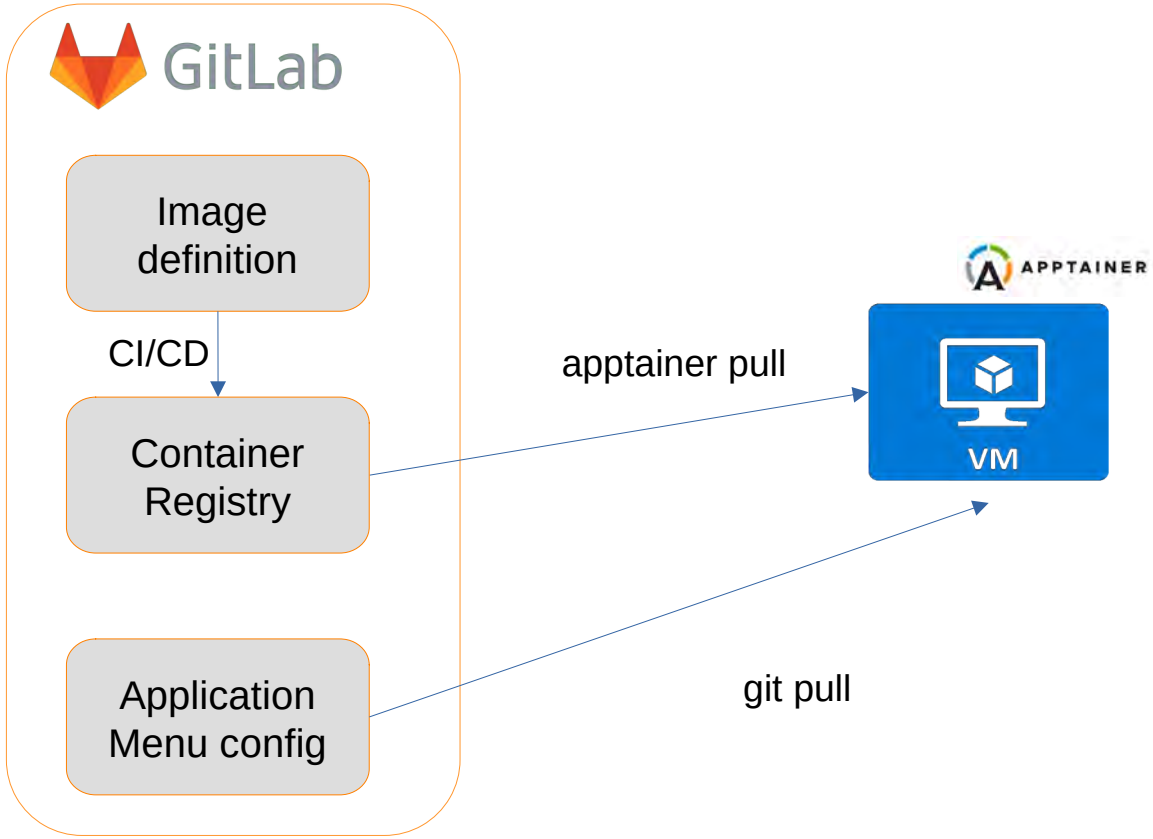
- Python script
- Customizable depending on the metadata source (catalogue API format, authN/Z, ...)
- Can be run once for static data or as a cronjob for dynamic data
- Event-based execution would be nice to have (e.g. webhooks)

- Metadata import
  - Experimental specifications
  - Dataset status (embargoed or public)
  - User access rights
  - Storage paths

- Database backup

visa.desy.de

Analysis software provisioning via Apptainer images



- Software in Apptainer images
  - Many applications already available as Apptainer image from HPC workflows
- Built from .def file in CI/CD pipeline
- Image publicly available in Gitlab registry
- Pulled on application startup

- Application menu entries defined separately in git repository
- Seamless integration into the OS applications
- Menu entries updated from menu config by cronjob pulls the repository regularly
- Seamless updates to the menu by admins

Open Data for DESY Photon Science

Summary

- Open Infrastructure Portal consisting of
  - Scicat as metadata catalog
  - dCache as storage system
  - VISA as data exploration and analysis portal

- Locally deployed and accessible via federated AAI with standard protocols

- Scicat as “single source of truth” w.r.t. storage locations and metadata

- Easy data dropping and long term storage via dCache

- Integration with VISA for remote data exploration and analysis
  - Allows reviewers to easily access data sets for publication reviews
  - Data value assessment before download

- Going forward this year to unfold its full potential and create a blueprint for a HIFIS service that could be adopted by interested Helmholtz centres and other institutions

Thank you

Questions ?

Contact

DESY. Deutsches
Elektronen-Synchrotron

www.desy.de

Tim Wetzel, Patrick Fuhrmann
IT-RIC (Research & Innovation in Scientific Computing)
tim.wetzel@desy.de, patrick.fuhrmann@desy.de

Replicable image analysis across domains

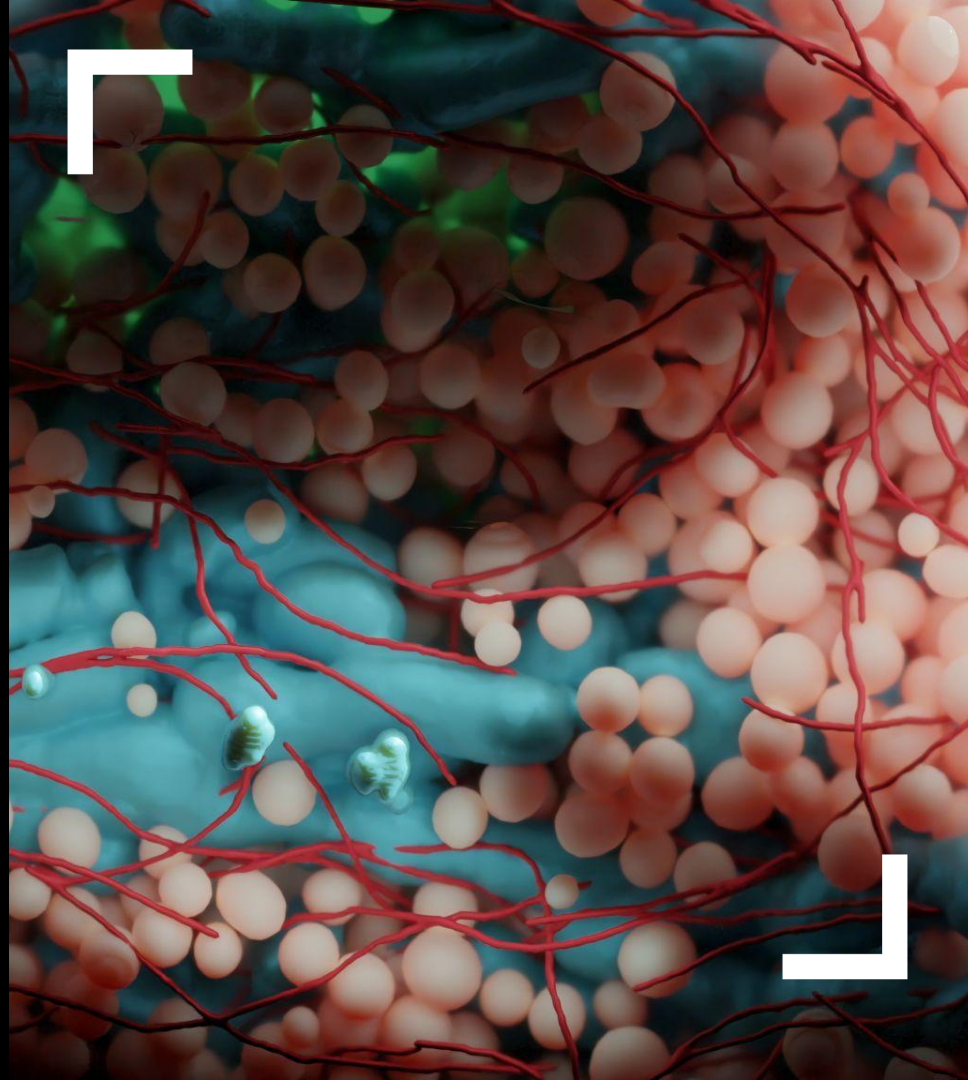
Deborah Schmidt

Head of Helmholtz Imaging Support Unit,

Max Delbrück Center for Molecular Medicine, Berlin

HELMHOLTZ IMAGING

MAX DELBRÜCK CENTER



Helmholtz Support Infrastructure

The Helmholtz Incubator Information & Data Science

HELMHOLTZ AI

HELMHOLTZ IMAGING

HiDA

HMC

HELMHOLTZ Open Science

HELMHOLTZ IMAGING

Unlock the potential of imaging in the Helmholtz Association

Sara Krause-Solberg

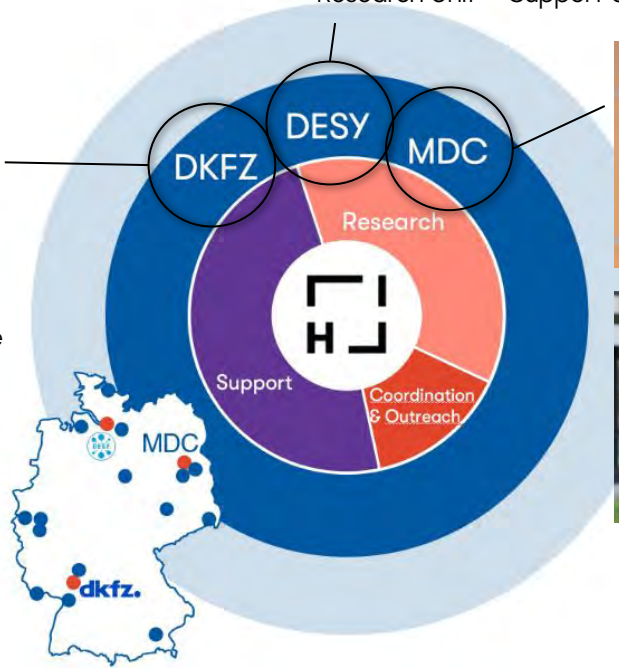
Scientific Coordinator, Management Unit

Martin Burger
Research Unit

Philipp Heuser
Support Unit

Paul Jäger
Research Unit

Fabian Isensee
Support Unit



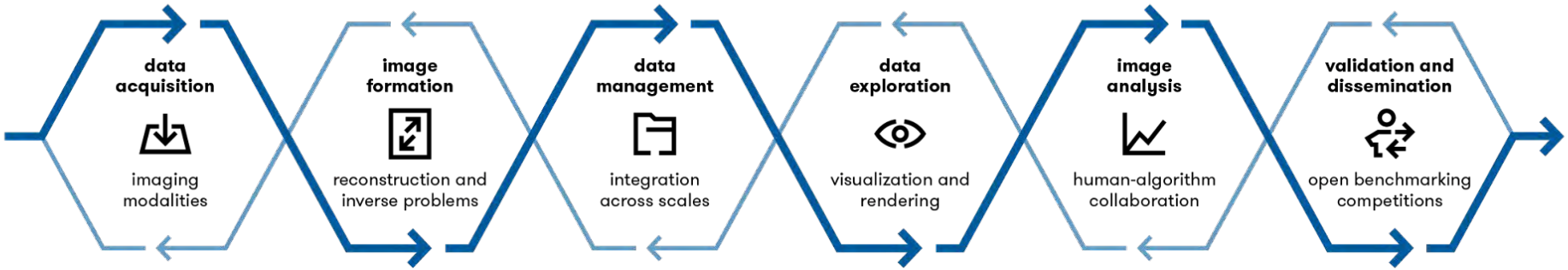
Dagmar Kainmüller
Research Unit

Deborah Schmidt
Support Unit

https://helmholtz-imaging.de

Helmholtz Imaging Support

Consulting along the entire pipeline and across all research domains



helpdesk@helmholtz-imaging.de

Digital image challenges and solutions along the pipeline

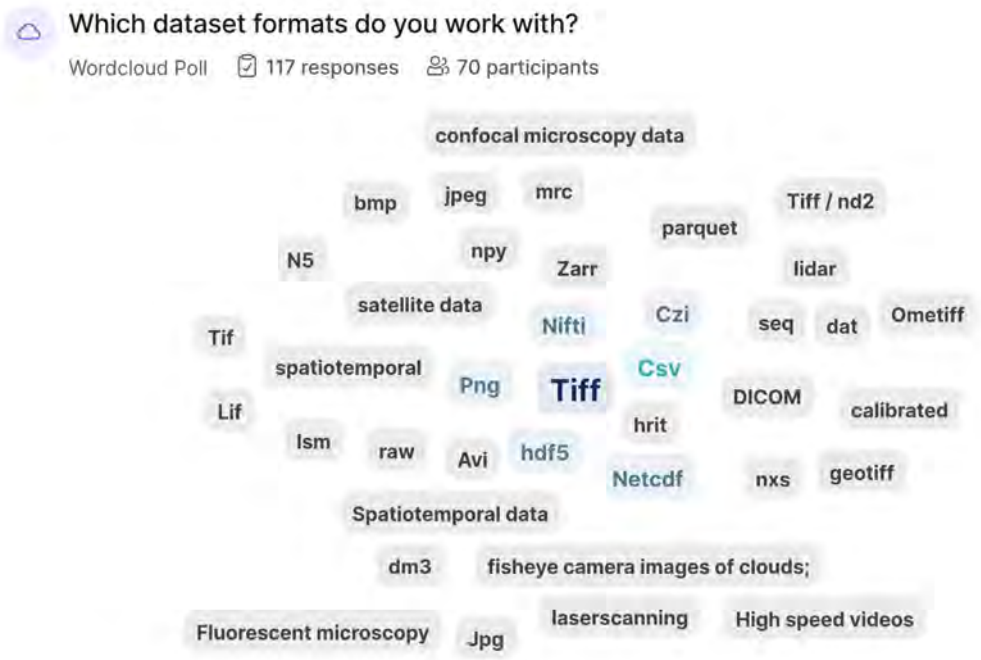
How do we achieve replicable image analysis solutions across domains?

1. **Observe and collect** challenges and solutions
2. **Assess and manage** specific solutions
3. Beyond replicability - **Generalizing** solutions

Observe and collect challenges and solutions

1. Observe and collect challenges and solutions

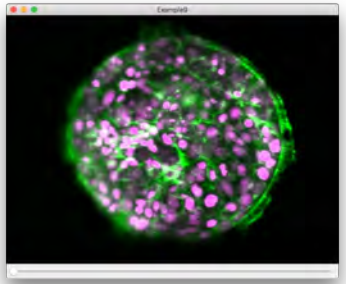
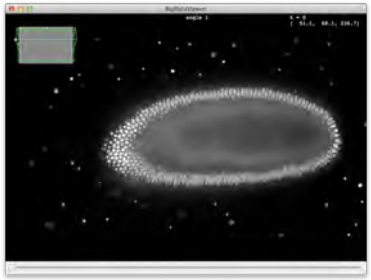
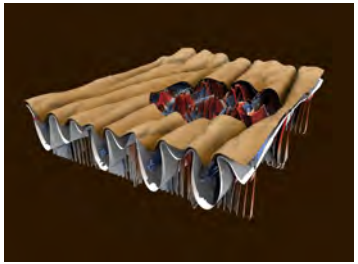
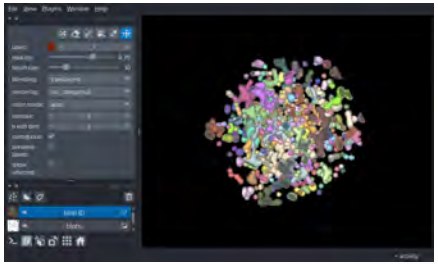
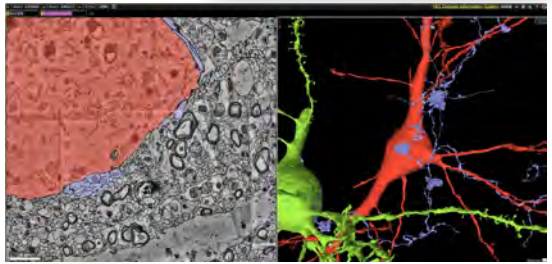
Abundance of data formats

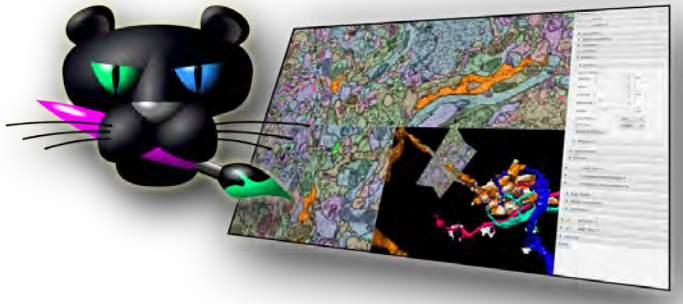
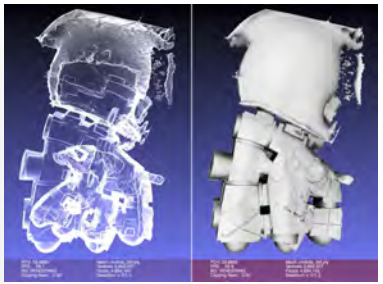


1. Observe and collect challenges and solutions

Abundance of diverse software solutions

Example: 3D Rendering Software

1. Observe and collect challenges and solutions

Helmholtz Imaging Connect

Modalities

A type of imaging technique that utilizes a certain physical mechanism to measure a quantity. Imaging modalities can be categorized by the method in which images are generated (ultrasound, light, electrons, lasers, X-rays, ultrasound, nuclear magnetic resonance, etc) and by some imaging particularity. For example, X-ray could include X-ray microtomography, X-ray crystallography and X-ray spectroscopy.

Applications

The object of study of a scientific field or a research field.

Instruments

A device used for making measurements, alone or in conjunction with one or more supplementary devices. A set of instruments belonging to the same platform can be grouped in a facility.

Centers

As Helmholtz Imaging is founded by the Helmholtz association, only the eighteen Helmholtz centers are referenced in the database. In case of missing center, please contact our Helmholtz Imaging Service Team at DESY Hamburg.

Labs

A lab is a collection of scientists, usually working in a team, usually at the same place having a teamleader. Here a lab can also be a virtual lab, being a consortium of people collaborating.

Facilities

A set of instruments combined to form an scientific or administrative unit.

Experts

All members of any of the Helmholtz Centers working with images, or on the development of methods for image processing or analysis, or are just interested in scientific imaging are considered Helmholtz Imaging Experts.

Solutions

A Solution in *Helmholtz Imaging Modalities* can be any kind of solution to an imaging challenge. Mostly this will be a software solution (executable software/algorithm/pipeline ...) or a dataset of images. But also a whitepaper describing the solution to a reoccurring imaging challenge can be listed here. This category also includes those solutions, which are installable via the Album catalogue of Helmholtz Imaging.

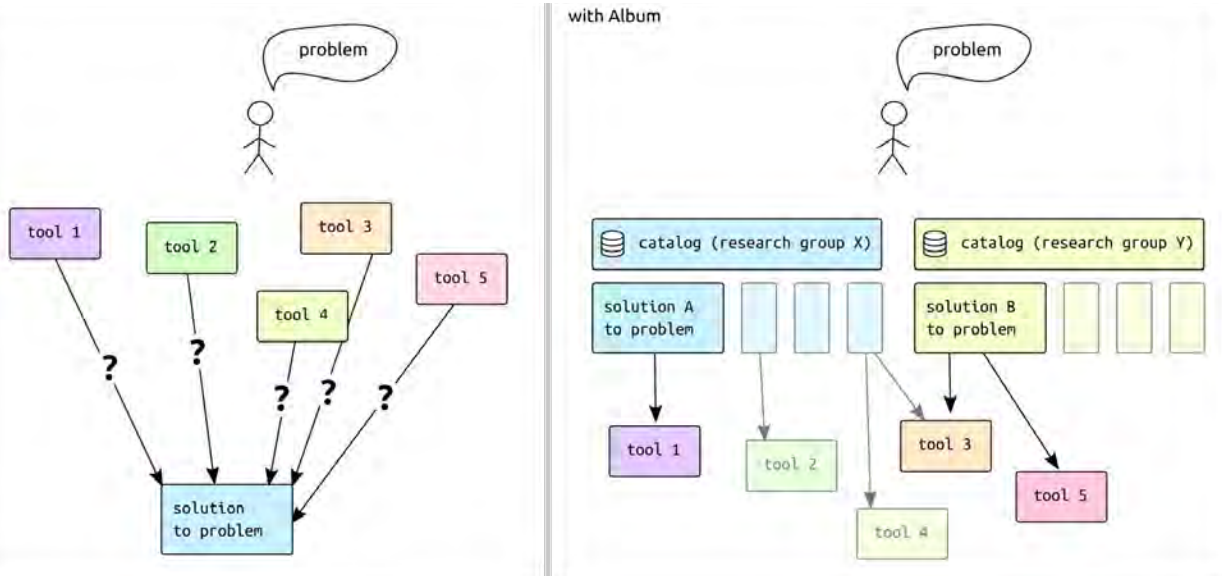
https://modalities.helmholtz-imaging.de

SOON https://connect.helmholtz-imaging.de

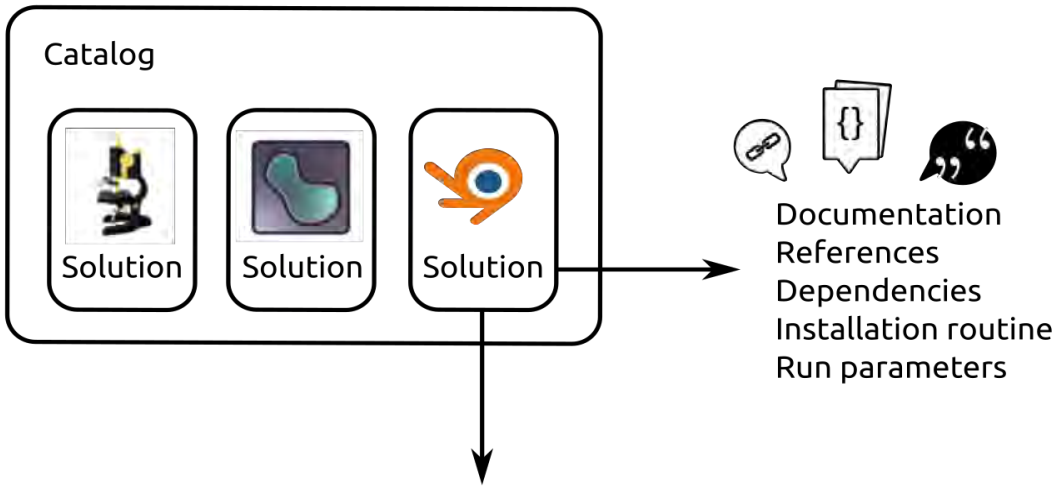
Philipp Heuser
Helmholtz Imaging
Support Unit DESY

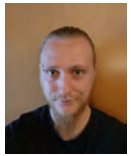
Assess and manage specific solutions

2. Assess and manage specific solutions



Decentralized distribution of executable software use cases





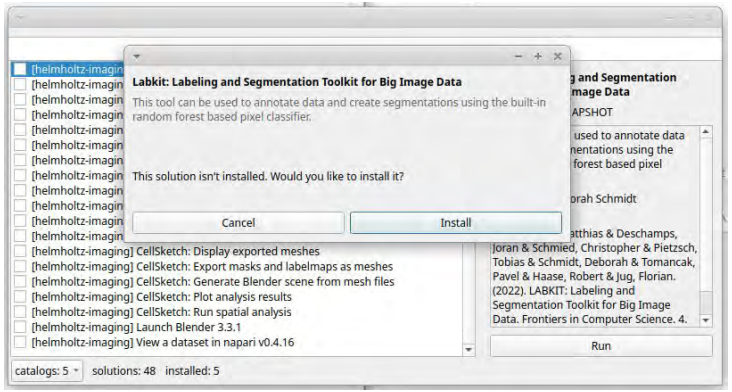
Jan Philipp Albrecht
Kyle Harrington
Lucas Rieckert
Deborah Schmidt
Maximilian Otto

Helmholtz Imaging
Support Unit MDC

https://album.solutions

Decentralized distribution of executable software use cases

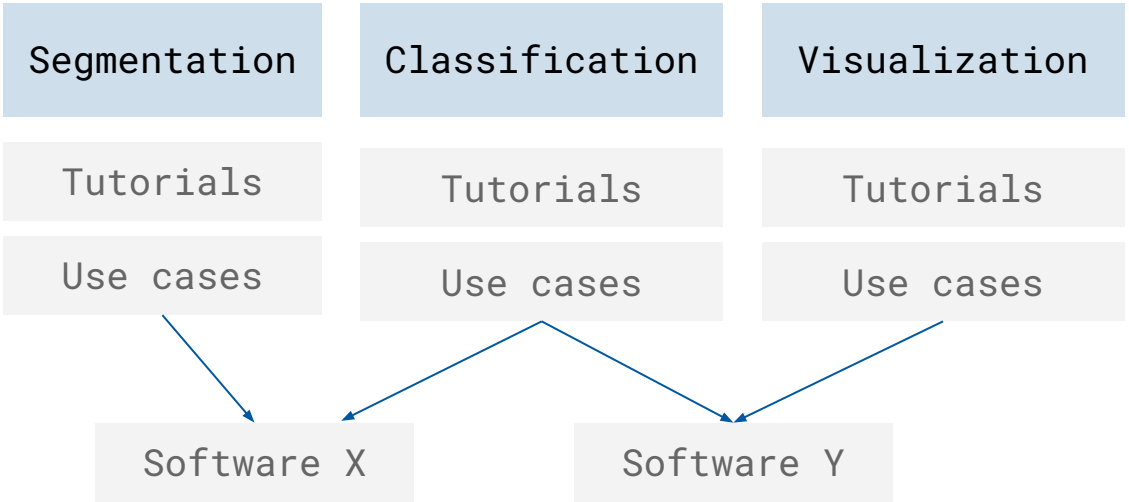
- Local execution of each solution in dedicated virtual environment
- Command line and graphical interface for catalog and launchers
- Automatically generated websites for catalogs



https://album.solutions

2. Assess and manage specific solutions

Ongoing effort: Album collection of executable best practices



Beyond replicability - Generalizing solutions

3. Generalize solutions

What are **Generalizing Imaging Solutions**?

Development of Generalizing Solution

Experience with recurring imaging tasks

Systematic analysis

Identification of relevant task and method characteristics

Define task fingerprint

Link Fingerprint with design choices

Generalizing Imaging Solution

Application of Generalizing Solution

Imaging task

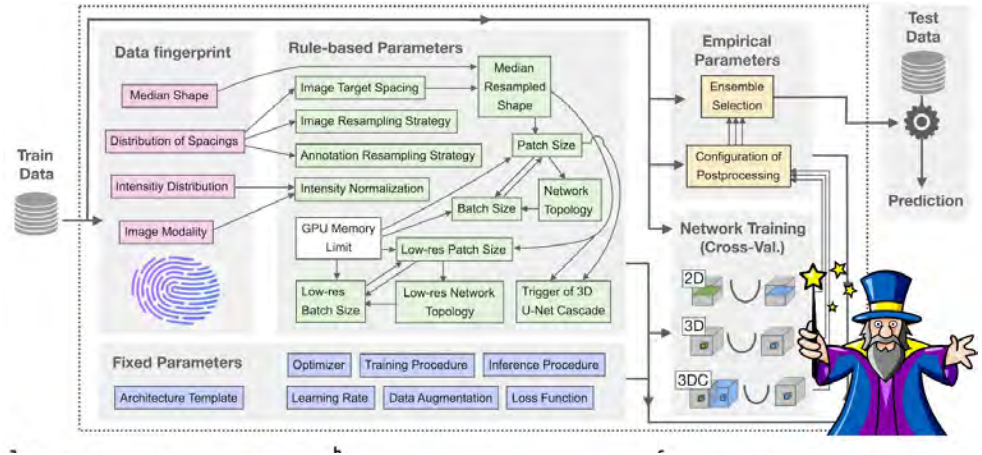
Extract task fingerprint

Generalizing Imaging Solution

Desired result

3. Generalize solutions

Example: **nnU-Net** - A self-configuring method for deep learning-based segmentation



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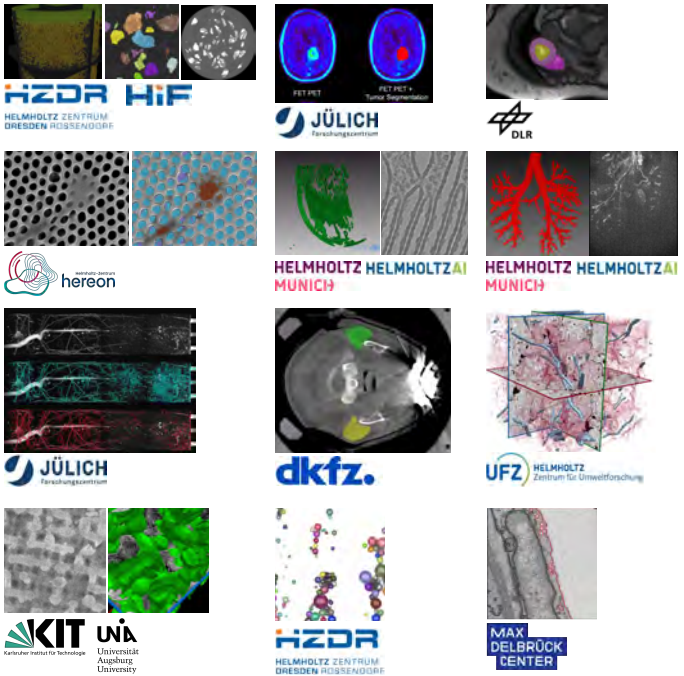
Units DKFZ



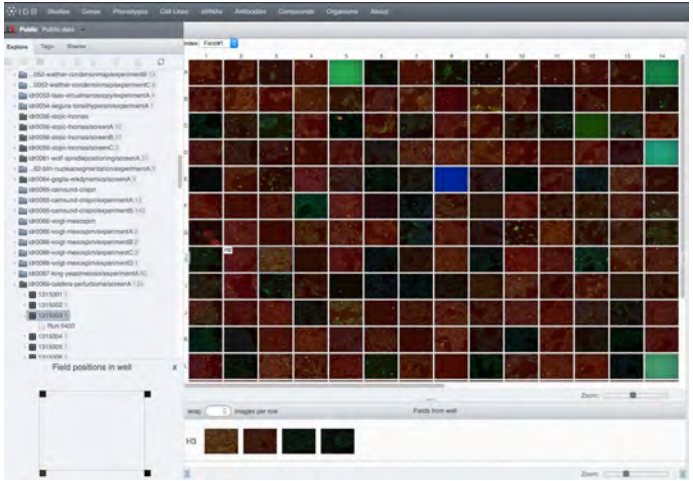
Isensee, F., Jaeger, P. F., Kohl, S. A., Petersen, J., & Maier-Hein, K. H. (2021). nnU-Net: a self-configuring method for deep learning-based biomedical image segmentation. Nature methods, 18(2), 203-211.

Learning from communities

Integrating and contributing to community efforts

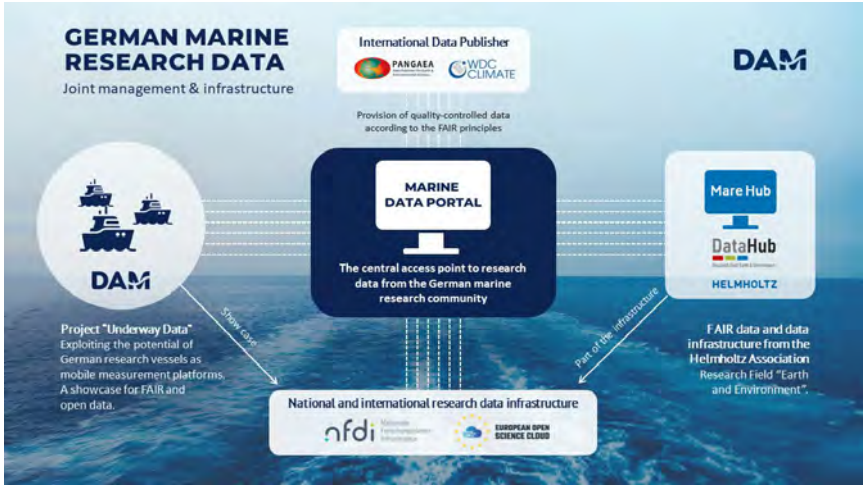
Omero
Bio-Formats

https://www.openmicroscopy.org



Marine Data Portal

https://marine-data.de



Integrating and contributing to community efforts

NFDI4BIOIMAGE

Consortium within the National Research Data Infrastructure (NFDI) of Germany
Focus on BioImaging data lifecycle in accordance with the FAIR principles

https://nfdi4bioimage.de

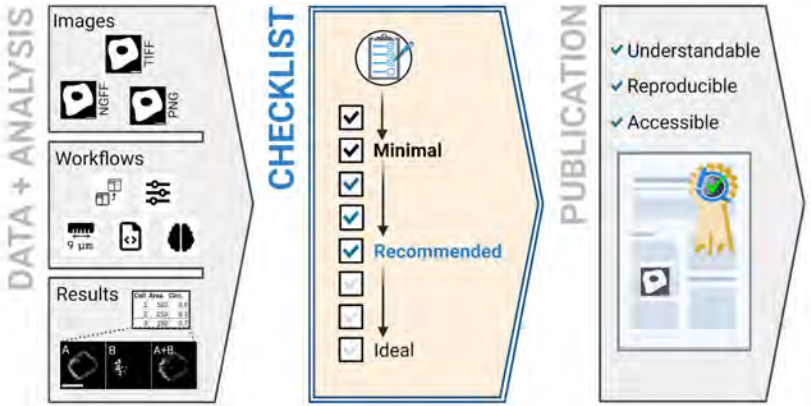
Helmholtz Research Software Directory

Promote and Discover Research Software

https://helmholtz.software/

QUAREP-LiMi

Quality Assessment and Reproducibility for Instruments & Images in Light Microscopy



https://quarep.org/

Thank you for listening!

helpdesk@helmholtz-imaging.de
https://connect.helmholtz-imaging.de

Helmholtz Imaging Team

Helmholtz Imaging Support Unit at MDC

Head of Platform
Deborah Schmidt

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Ella Bahry

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Working Student
Maximilian Otto

Write me: **deborah.schmidt@mdc-berlin.de**

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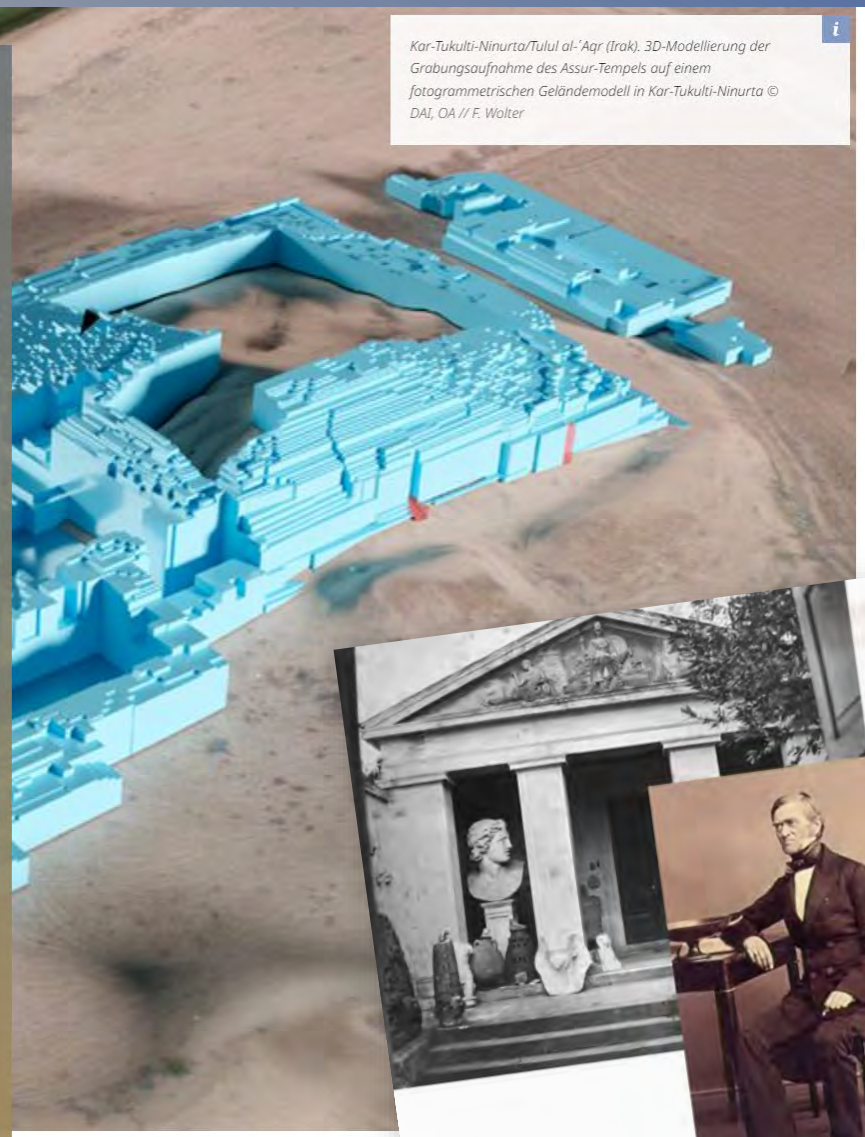
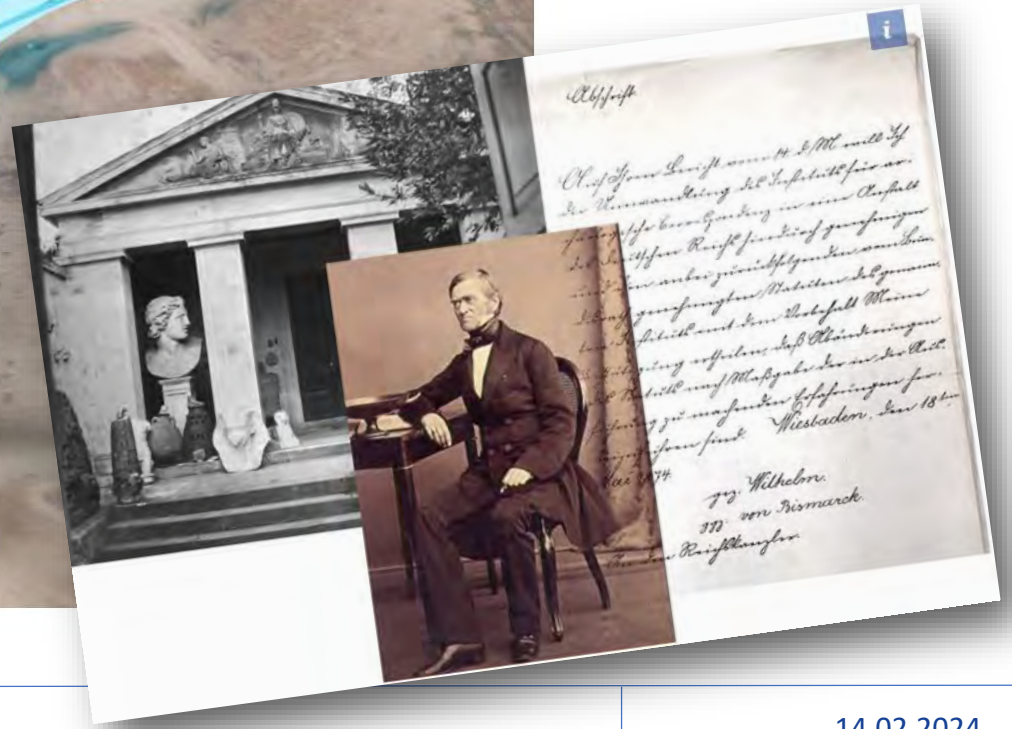
IDAI.WORLD

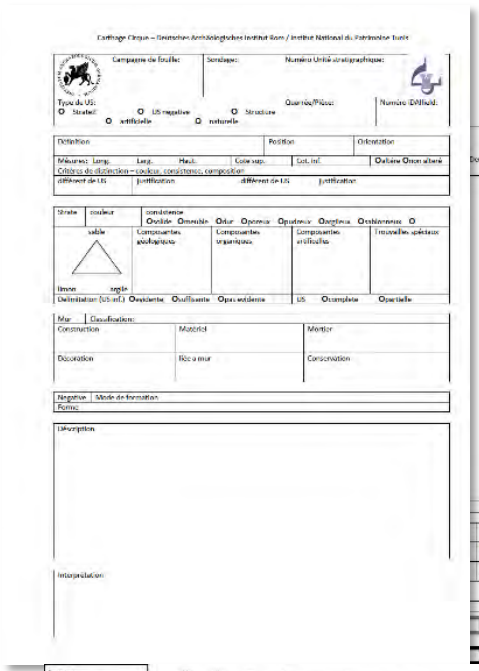
Research for dialogue between cultures, cooperation worldwide and the preservation of cultural heritage.

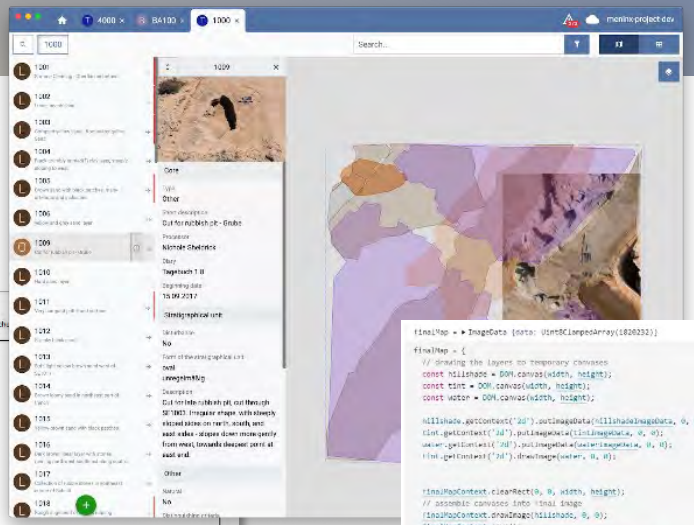
WHO WE ARE RESEARCH CAREER CONTACT

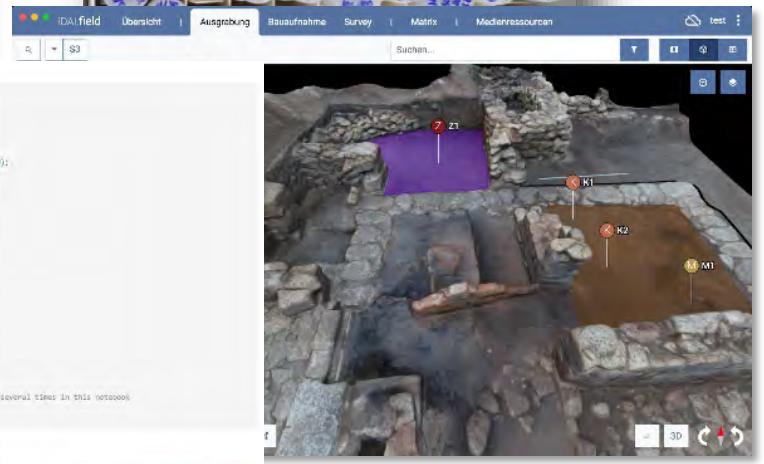


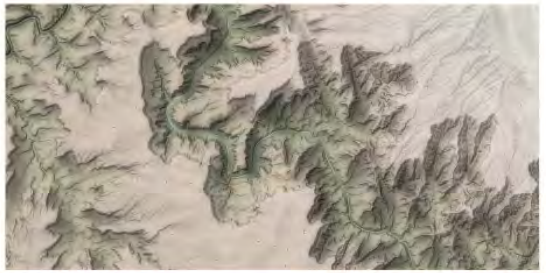
Kar-Tukulti-Ninurta/Tulul al-'Aqr (Irak). 3D-Modellierung der Grabungsaufnahme des Assur-Tempels auf einem fotogrammetrischen Geländemodell in Kar-Tukulti-Ninurta © DAI, OA // F. Wolter

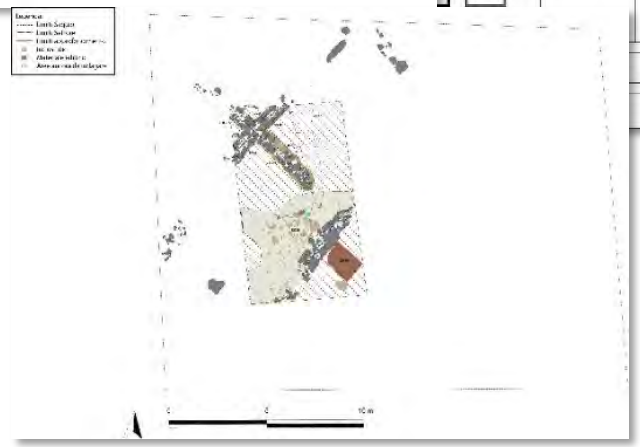


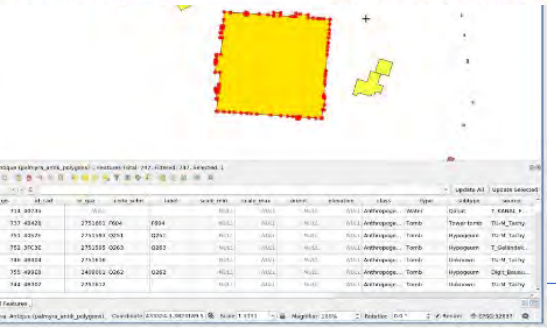


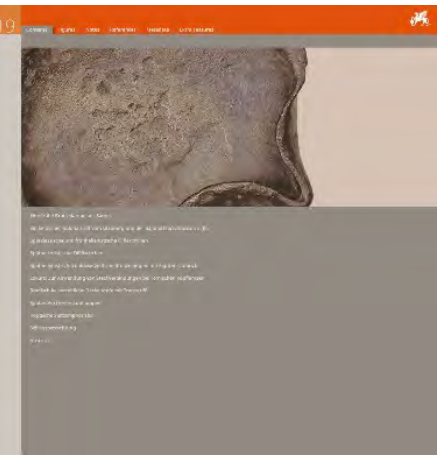












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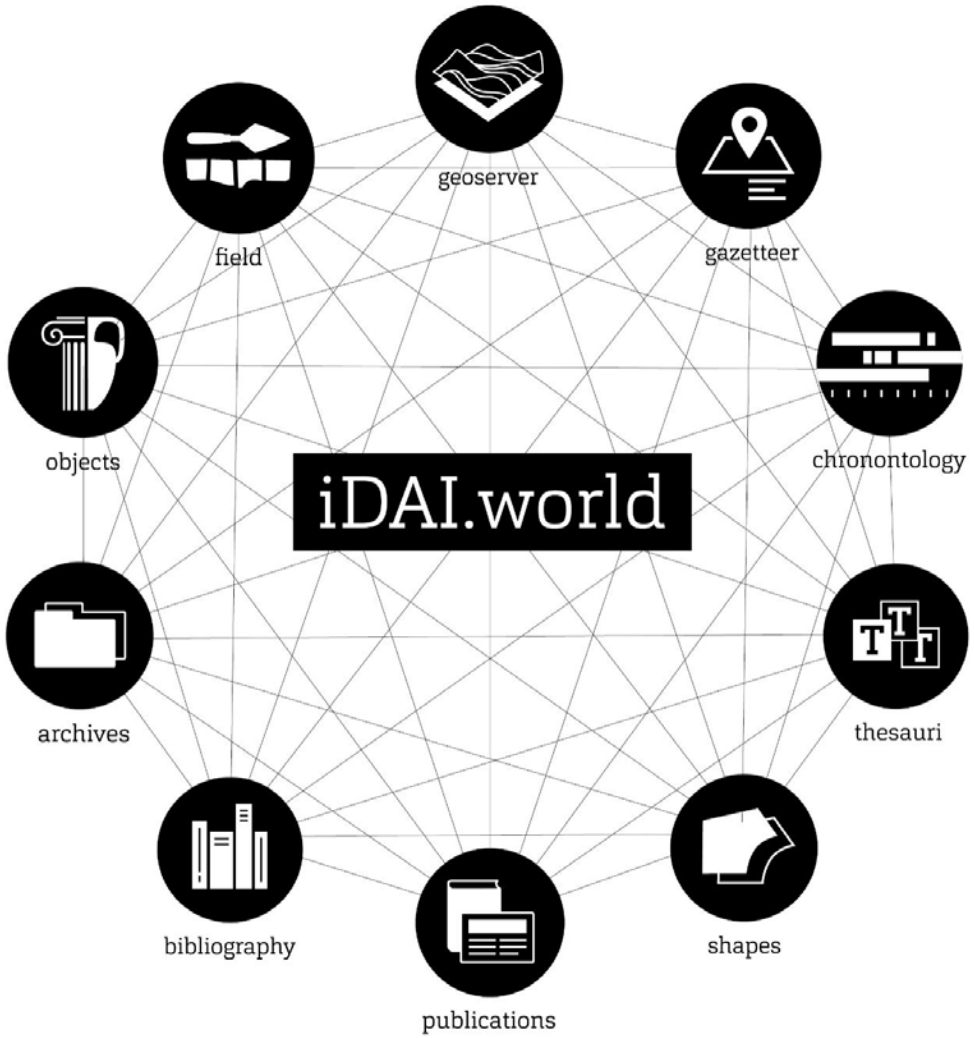
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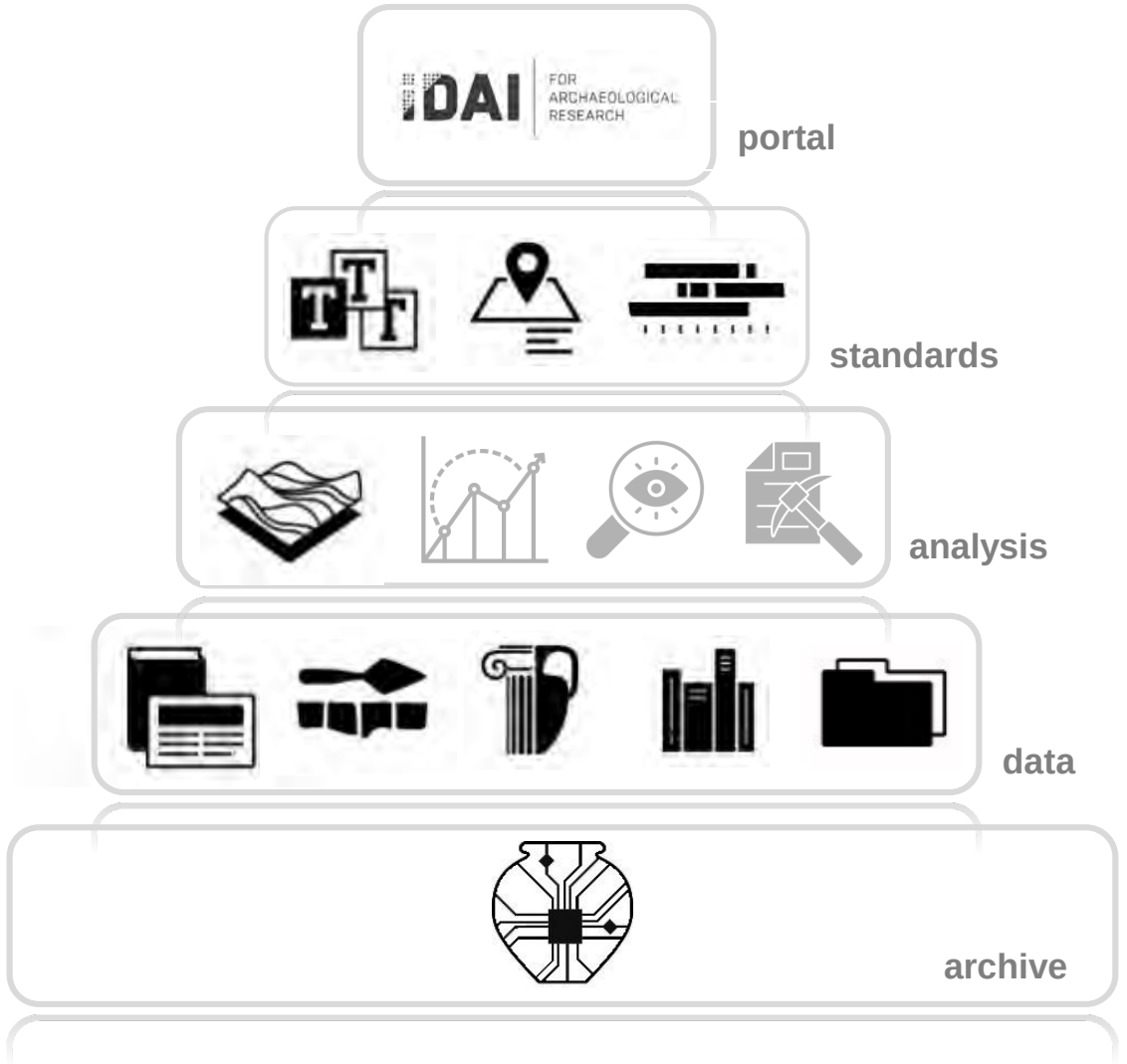
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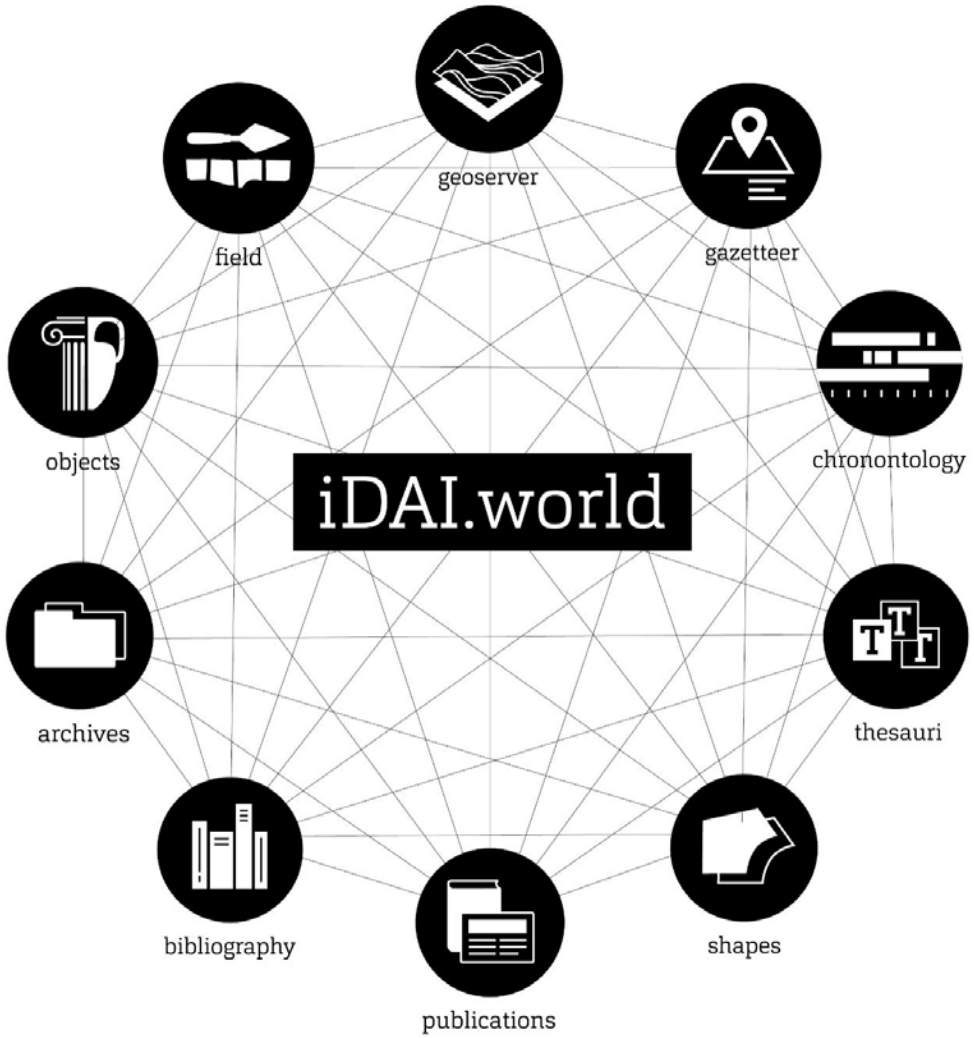
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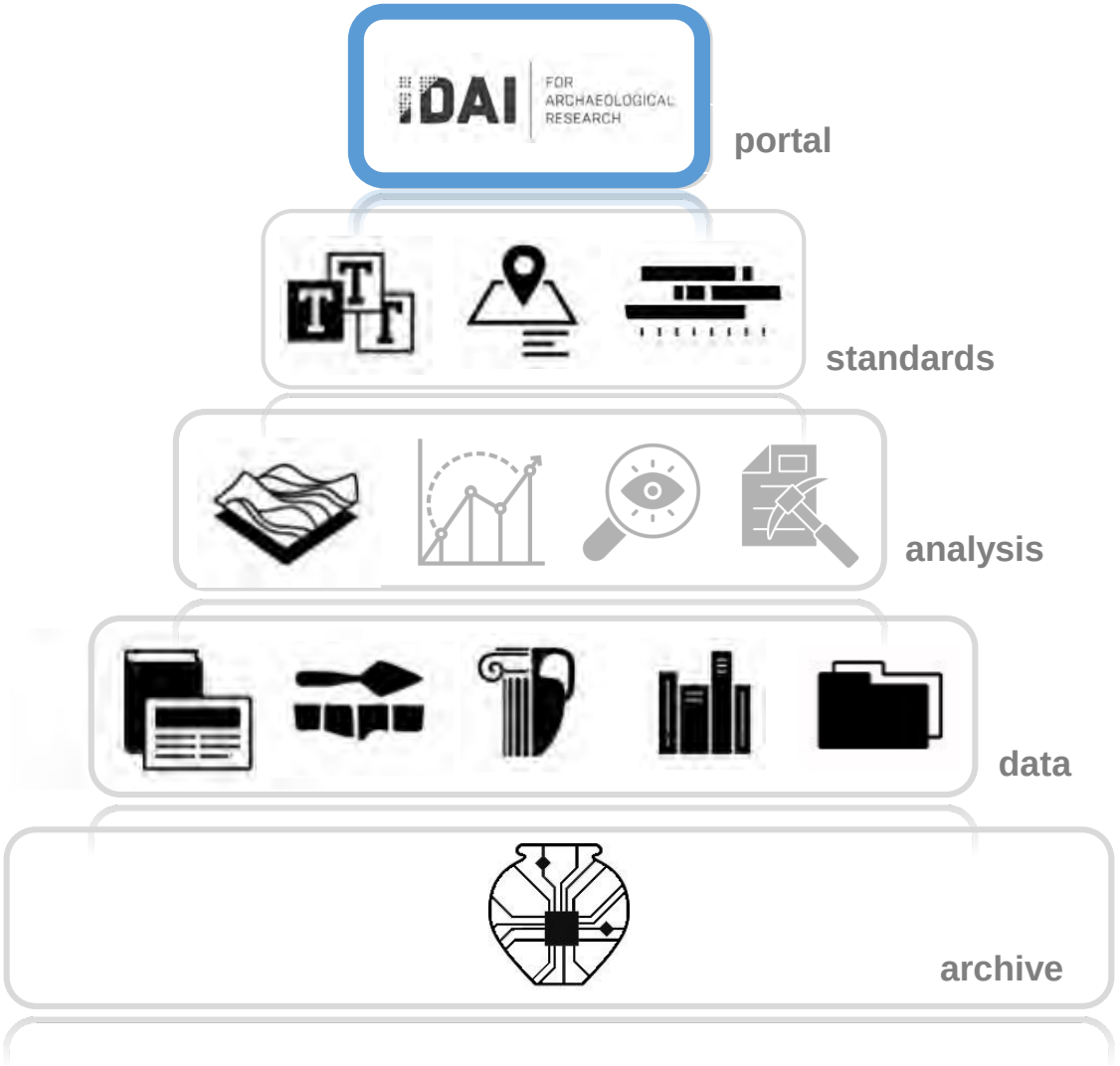
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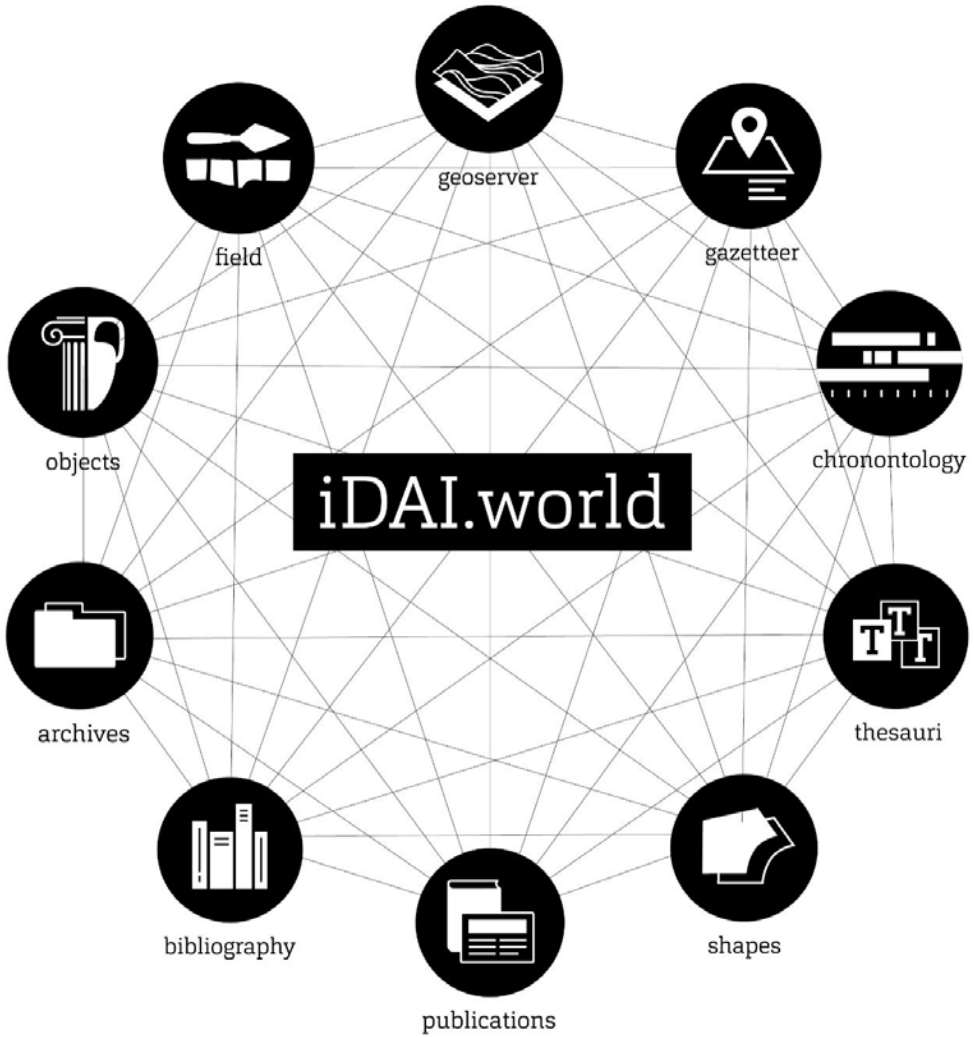
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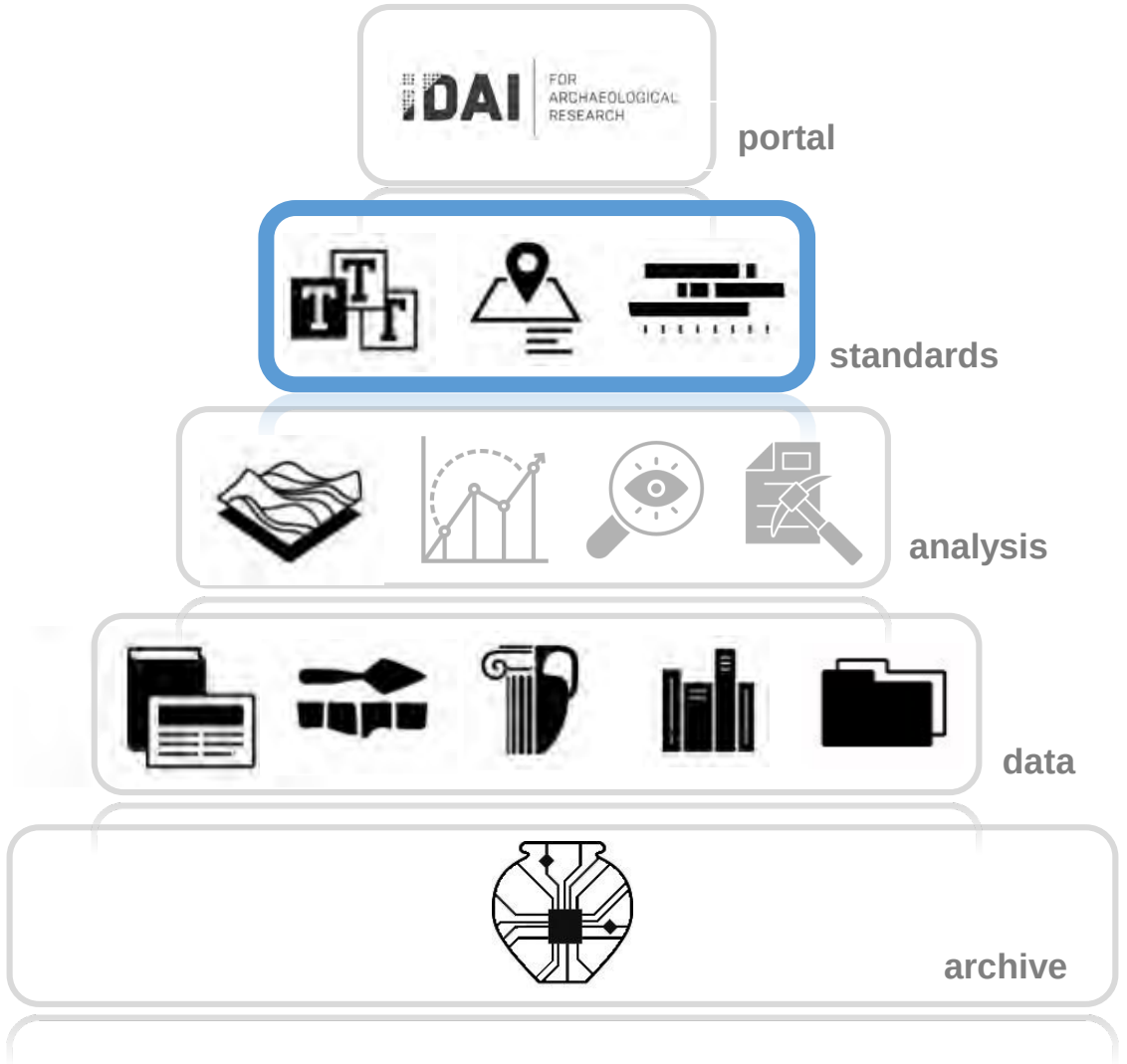
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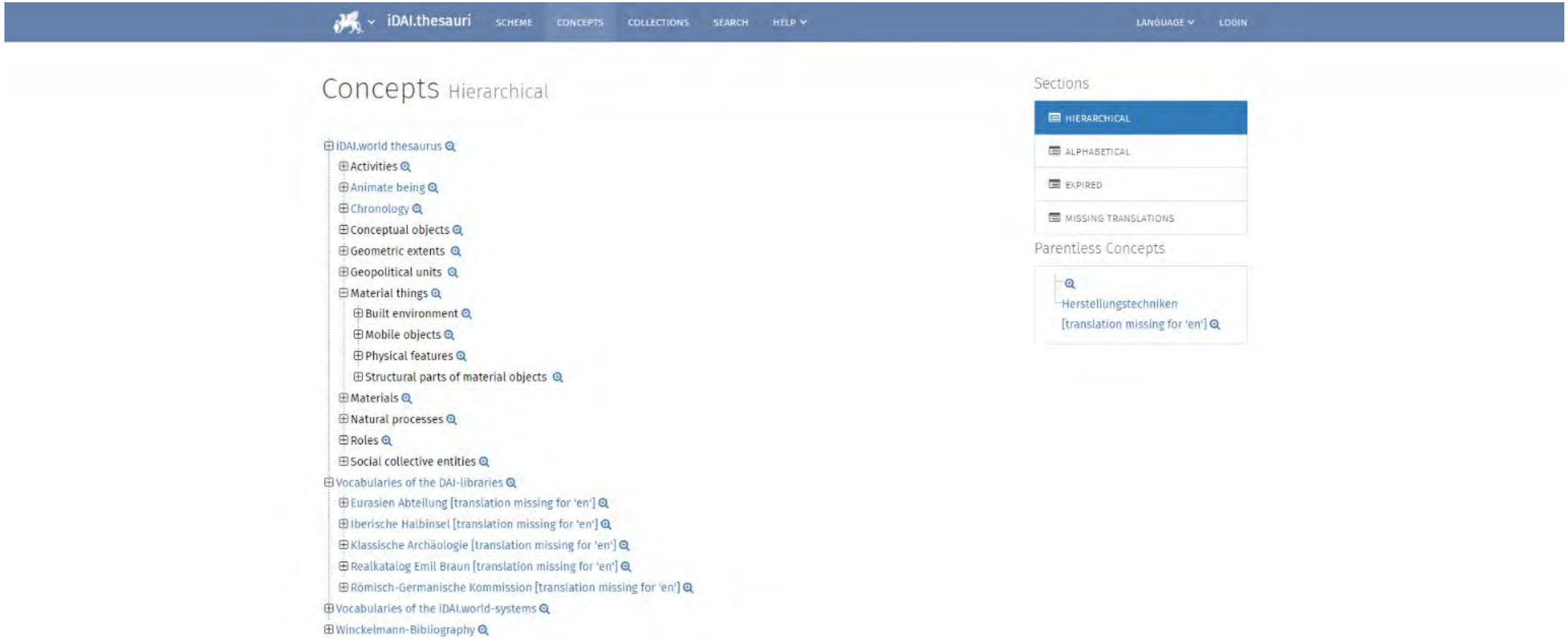
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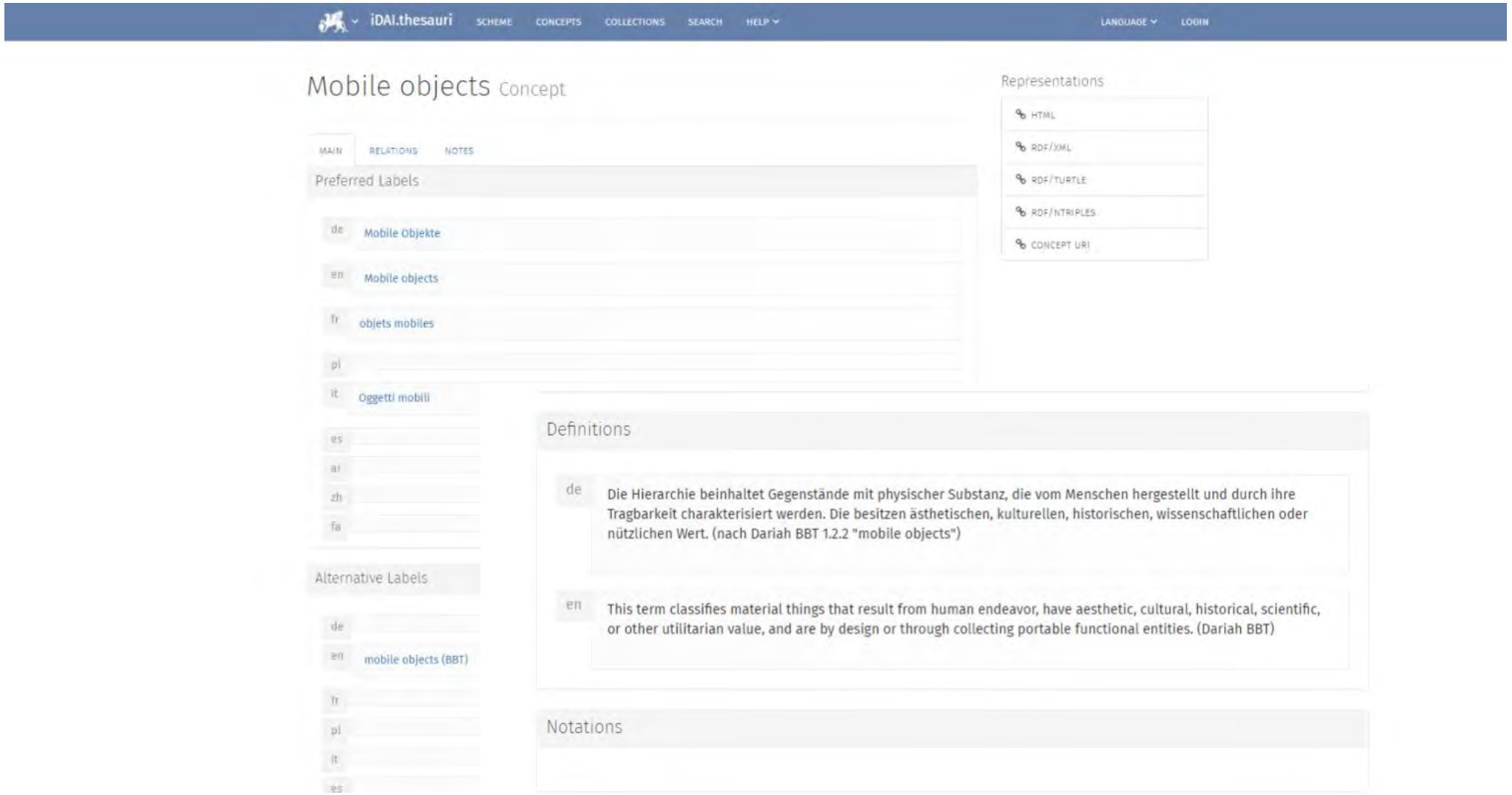
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Alternative Labels
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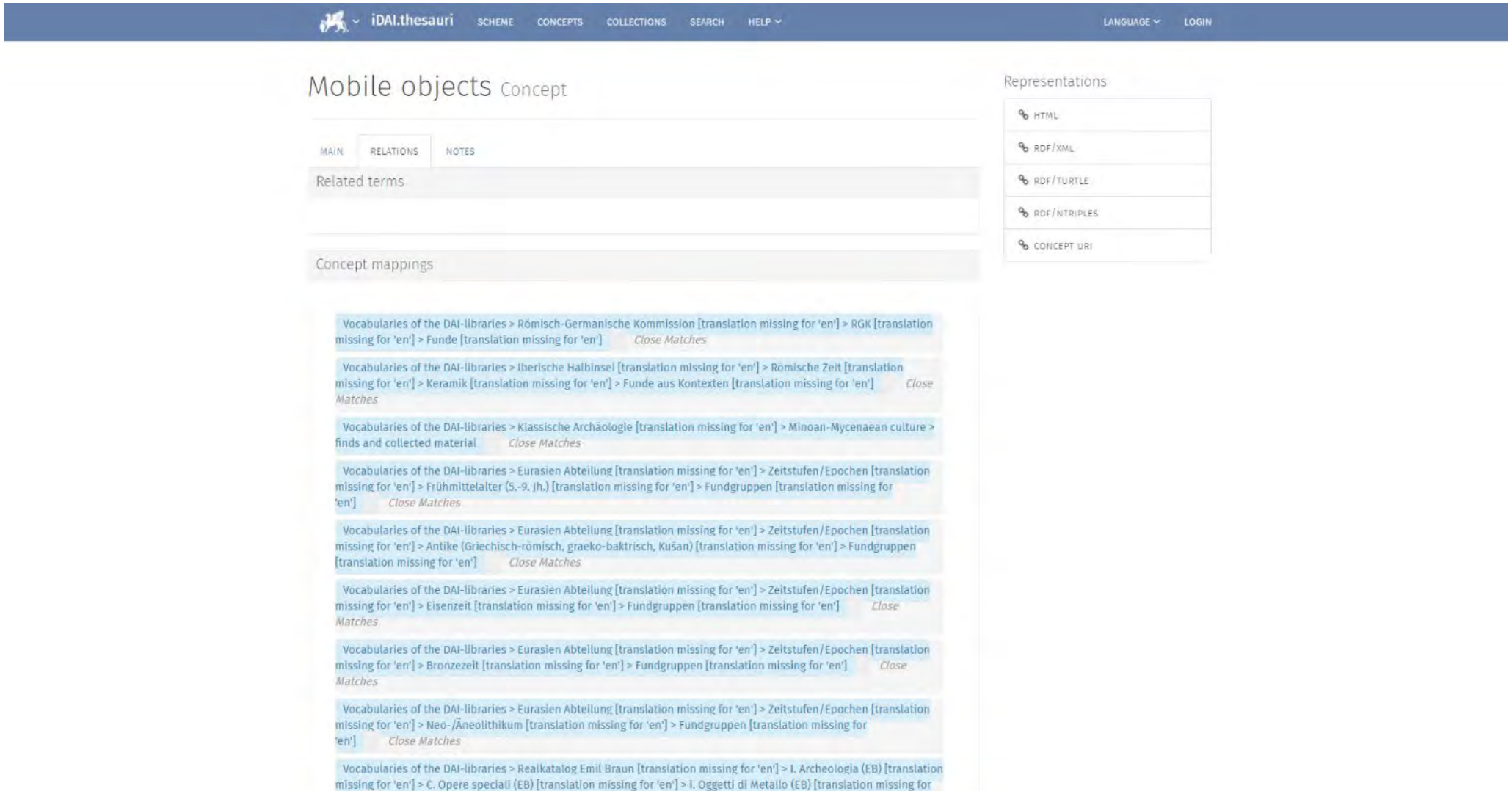
RDF/XML
RDF/TURTLE
RDF/NTRIPLES
CONCEPT URI
Definitions
de Die Hierarchie beinhaltet Gegenstände mit physischer Substanz, die vom Menschen hergestellt und durch ihre Tragbarkeit charakterisiert werden. Die besitzen ästhetischen, kulturellen, historischen, wissenschaftlichen oder nützlichen Wert. (nach Dariah BBT 1.2.2 "mobile objects")
en This term classifies material things that result from human endeavor, have aesthetic, cultural, historical, scientific, or other utilitarian value, and are by design or through collecting portable functional entities. (Dariah BBT)
Notations

thesauri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Roman political (Römisches Reich)

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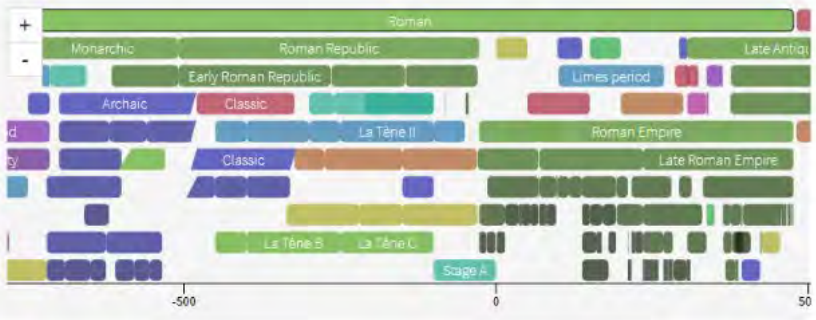

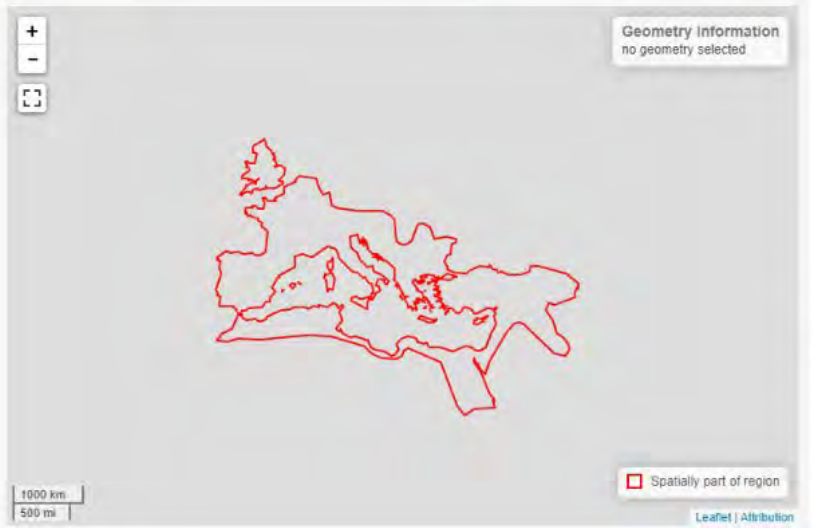

Information | Download JSON

About the period

Names
Römisches Reich *(de)*
Römisch *(de)*
Roman *(en)*

Period type political

Digital provenance chronOntology

Description The great Latin historian Tacitus opens his Annals with a deft summary of the evolution of the Roman state, beginning with the words 'The city of Rome was, from the start, ruled by kings'. As his words suggest, Roman periodicization of Roman history was based on forms of government, basically: immediately after Rome's foundation (traditionally, in 753 BC, rule by kings (the 'regal' period); next (traditionally, from 509 BC) rule by a Republic (aristocratic, not democratic, but nonetheless obedient to regularly elected officials: 'magistrates'); and finally (from 27 BC) rule by emperors (principes).' Modern historians follow suit, and subdivide both Republican and imperial history into 'early', 'middle' and 'late' periods, thus referring to the 'Early' Republic, the 'High' Republic and the 'Late' Republic, and to the 'Early', 'High' and 'Late' Empire. The distinction between 'Republic' and 'Empire' can be a Role confining to newcomers, because Rome's empire was for the most pan a Republican creation. However, it works well enough, and is here to stay. A further complication is that there is lively debate as to the specific dates of some of these periods: when did the Early Republic end, or the Late Empire begin?
(source: Introduction. John Drinkwater. in: A Chronology of the Roman Empire. 2001. Timothy Venning; https://zenon.dainst.org/Record/000879128)

Tags roman_chronology

Temporal extent *Begin:* -753 (ca.)
End: 476 (ca.)

Spatially part of region Römisches Reich

Relations

Is a sense of Roman (not specified) iDAI.objects Arachne

Is part of Classical antiquity (not specified) iDAI.objects Arachne

Has parts Late Antique (political, cultural)
Monarchic
Roman Republic

gazetteer

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Römisches Reich https://gazetteer.dainst.org/place/2359913

← back Show Similar places

Place information

Names *Preferred name:* Römisches Reich *German*
Römisches Imperium *German*
الإمبراطورية الرومانية *Arabic*
Roman Empire *English*
Imperium Romanum (Ancient) *Latin*

Location *Polygon specified*

Type Archaeological area

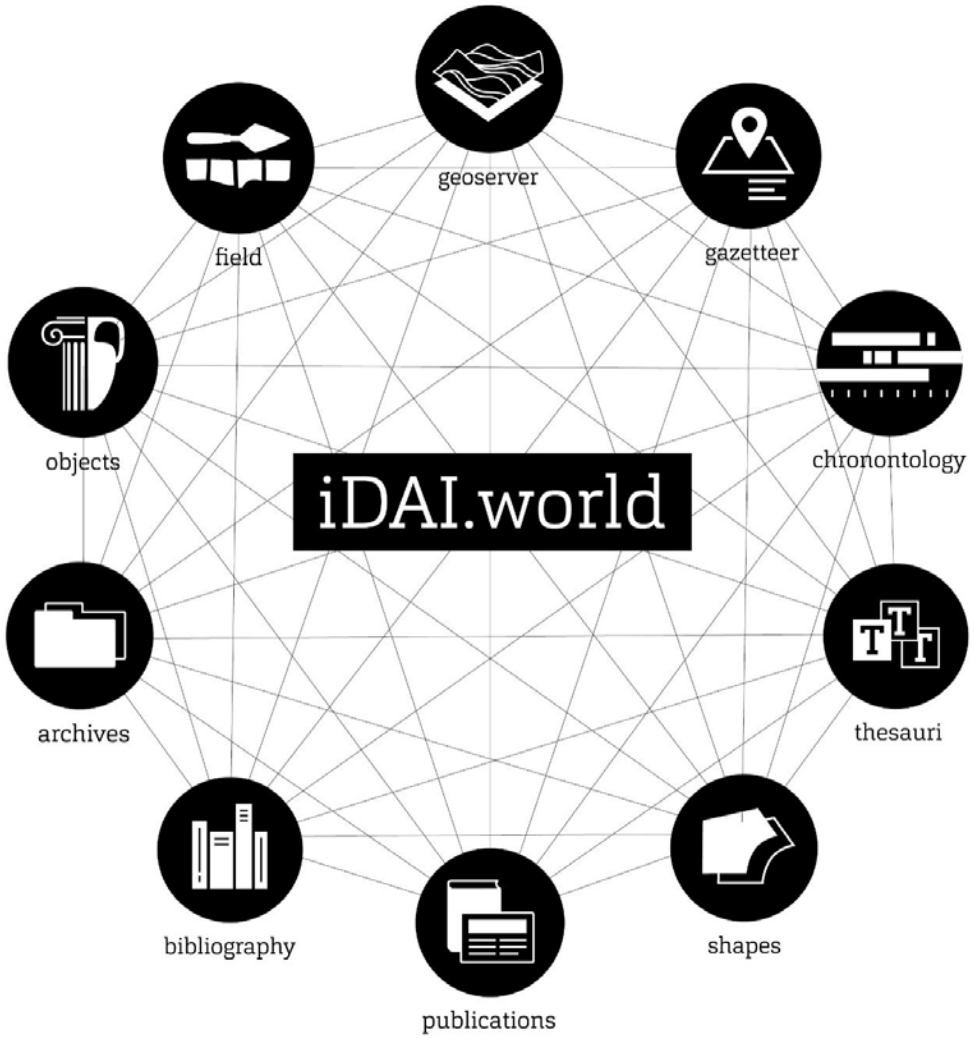
Contexts Search for linked objects in iDAI.objects
Search for linked entries in iDAI.bibliography

Falls within Welt
_Geographische Regionen (Welt)

Contains *4 places in total:*
- Praefectura praetorio Galliarum, *Praetorian Prefecture of Gaul, Prefettura del pretorio delle Gallie*
- Praefectura praetorio Italiae, *Praetorian prefecture of Italy, Praefectura Praetorio Italiae et Africae, Prefettura d'Italia, ...*
- Praefectura praetorio Orientis, *Praetorian prefecture of the East, Praetorian prefecture of the Orient, Prefettura del pretorio d'Oriente*
- Praefectura praetorio per Illyricum, *Praetorian prefecture of Illyricum, Prefecture of Illyricum, Prefettura del pretorio dell'Illirico*

Related places *44 places in total:*
- Aegyptus, *Ägypten (römische Provinz), Egypt (Roman province), Égypte (province romaine), ...*
- Africa Byzacena, *Byssátis, Byzákis, Bućākiç ...*
- Africa Proconsularis, *Afrika (römische Provinz), Africa (Roman province), Afrique (province romaine), ...*
- Albania, *Albanien, Republika e Shqipërisë, Shqipëria, ...*
- Algerien, *Algerien, Algjeri, Algjeria, ...*
- Balkan
- Belgique, *Belgien, Königreich Belgien, Belgjika, ...*
- Bosnien-Herzegowina, *Bosnien und Herzegowina, Bosnja dhe Hercegovina, البوسنة والهرسك, ...*
- Bulgarien, *Bulgarien, Bullgari, Bullgaria, ...*
- Egypt, *Ägypten, Egjipt, Egjipti, ...*

Tags Historical administrative unit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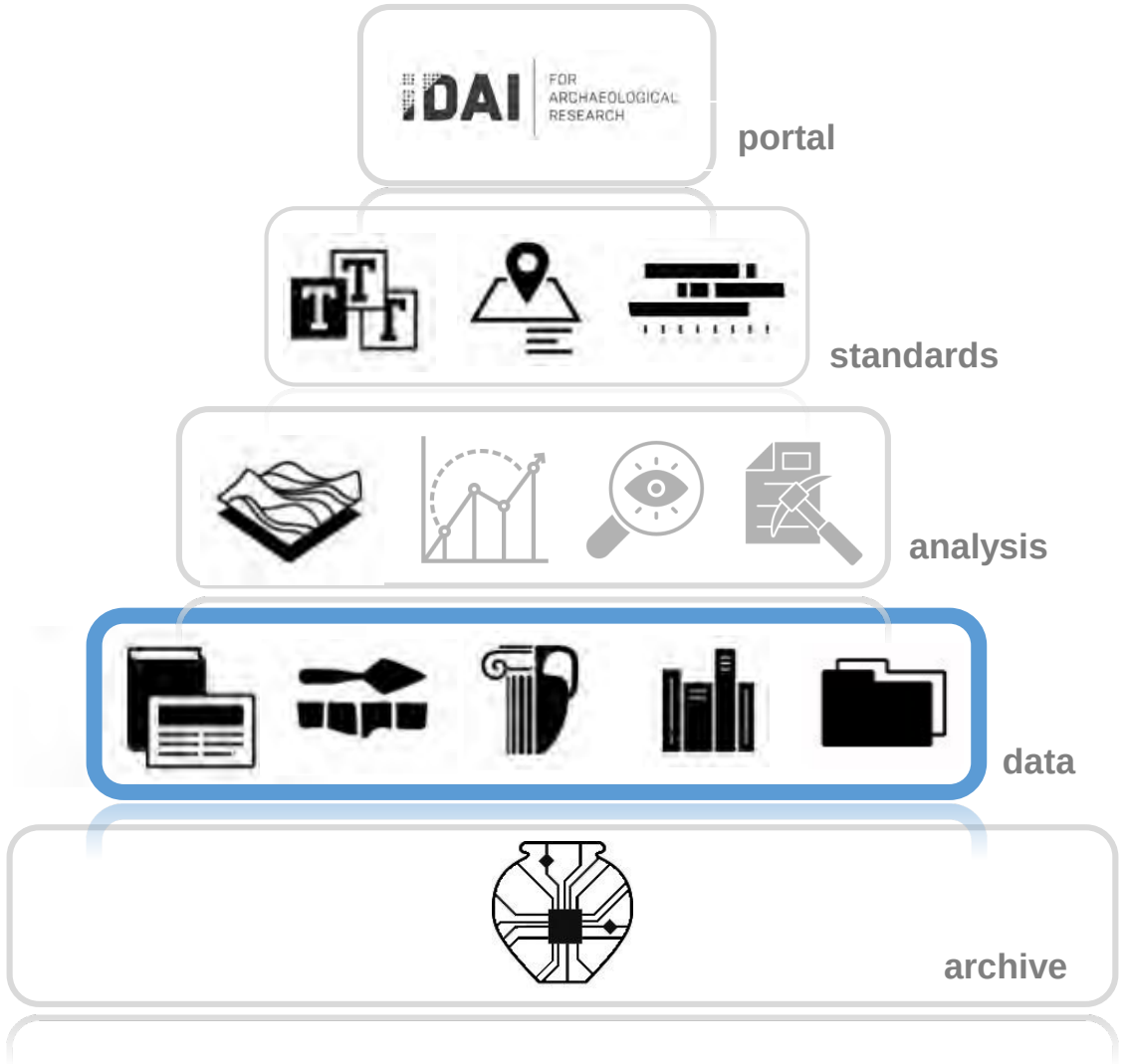

IDAI FOR ARCHAEOLOGICAL RESEARCH
portal
standards
analysis
data
archive

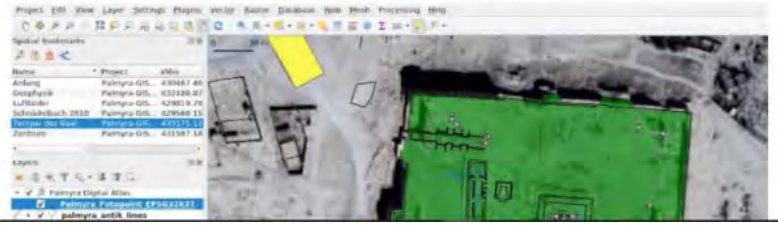
„Palmyra GIS“ - Digitaler Kulturerhalt in Syrien

Forschende des Deutschen Archäologischen Instituts haben die digitale webbasierte Anwendung „Palmyra GIS“ entwickelt. Mit der Anwendung und dem dazugehörigen 3D-Druck des Geländemodells der syrischen antiken Ruinenstadt Palmyra möchten die Forschenden zum Schutz des durch den syrischen Krieg gefährdeten Weltkulturerbes beitragen.

Auf Basis eines geographischen Informationssystems (GIS) erstellten Dr. Benjamin Ducke und sein Team die Anwendung „Palmyra GIS“. Es kombiniert kartographische Werkzeuge mit einer flexiblen Datenbank. Nutzer haben nun Gelegenheit über eine webbasierten Benutzeroberfläche auf die Daten zuzugreifen. In den letzten Jahren trugen Forschende unter anderem große Mengen von Fotos, Karten und Luftbilder zusammen. Forschende des DAI digitalisierten analoge Datensätze oder erstellten neue digitale Daten, die nun erstmals zugänglich sind. Kartengrundlage von „Palmyra GIS“ ist eine erweiterte digitale Version der Karte „Topographia Palmyrena“, die Klaus Schnädelbach (TU München) 2010 in Zusammenarbeit mit der Außenstelle Damaskus des DAI publizierte. Die gesammelten Daten sind nun mit dieser digitalen Version der Karte verknüpft und bilden eine einmalige und umfassende Sammlung detaillierter geographischer Daten zu Palmyra.

Die webbasierte Anwendung „Palmyra GIS“

Dank verschiedener Benutzeroberflächen kann es von Fachleuten und fachfremden Personen genutzt werden. NutzerInnen können durch Verlinkungen auf der digitalen Karte auf Fotos, Pläne und Textinformationen aus der großen Sammlung des DAI zugreifen. Alle wichtigen Monumente sind mit der DAI Online-Datenbank auf verbunden.



Inhalt

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Die webbasierte Anwendung „Palmyra GIS“
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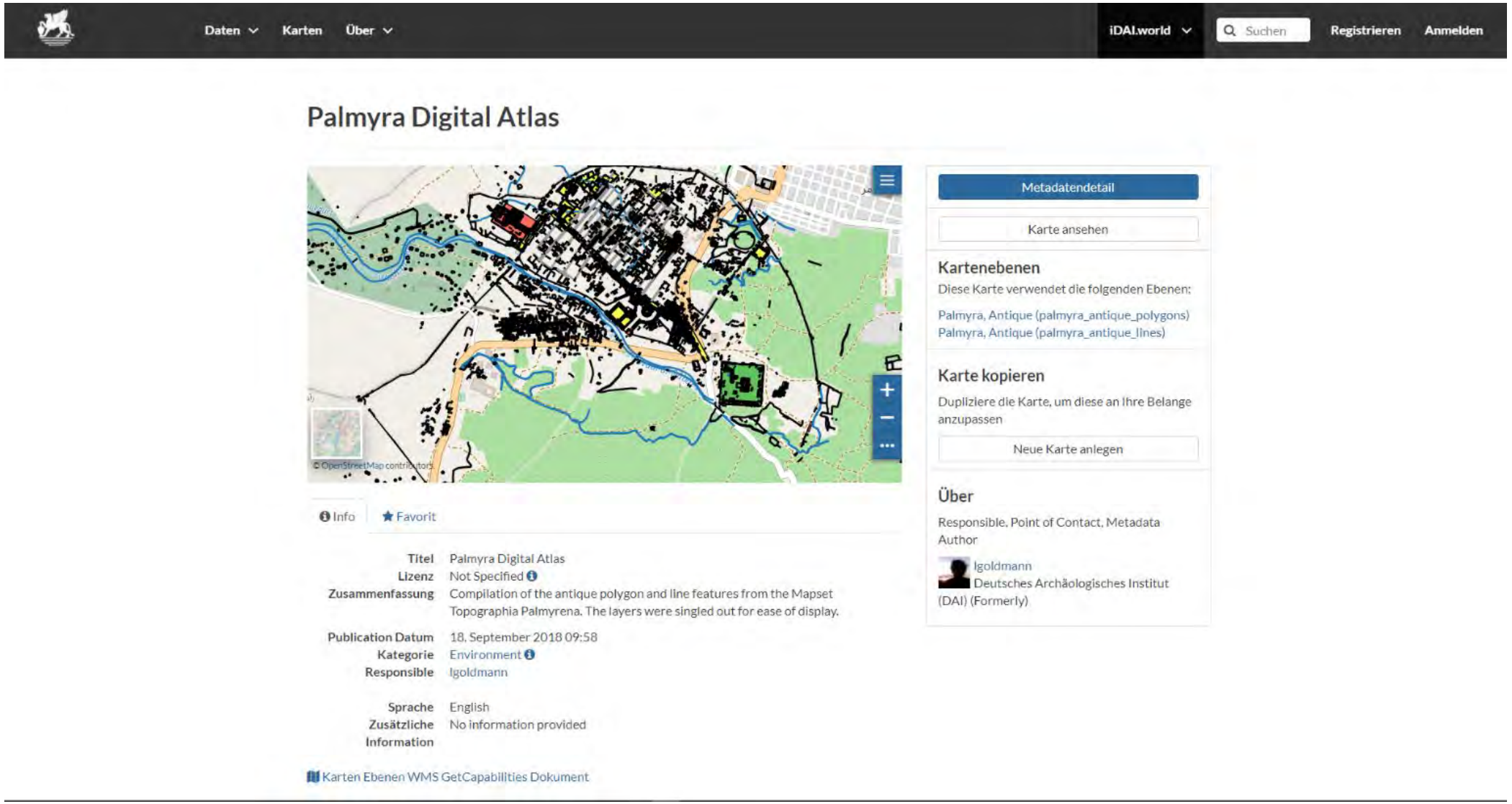
Digitaler Kulturerhalt für die Zukunft

geoserver


Daten
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Karte ansehen
Kartenebenen
Diese Karte verwendet die folgenden Ebenen:
Palmyra, Antique (palmyra_antique_polygons)
Palmyra, Antique (palmyra_antique_lines)
Karte kopieren
Dupliziere die Karte, um diese an Ihre Belange anzupassen
Neue Karte anlegen
Über
Responsible, Point of Contact, Metadata Author
lgoldmann
Deutsches Archäologisches Institut (DAI) (Formerly)
Info
Favorit
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Lizenz Not Specified
Zusammenfassung Compilation of the antique polygon and line features from the Mapset Topographia Palmyrena. The layers were singled out for ease of display.
Publication Datum 18. September 2018 09:58
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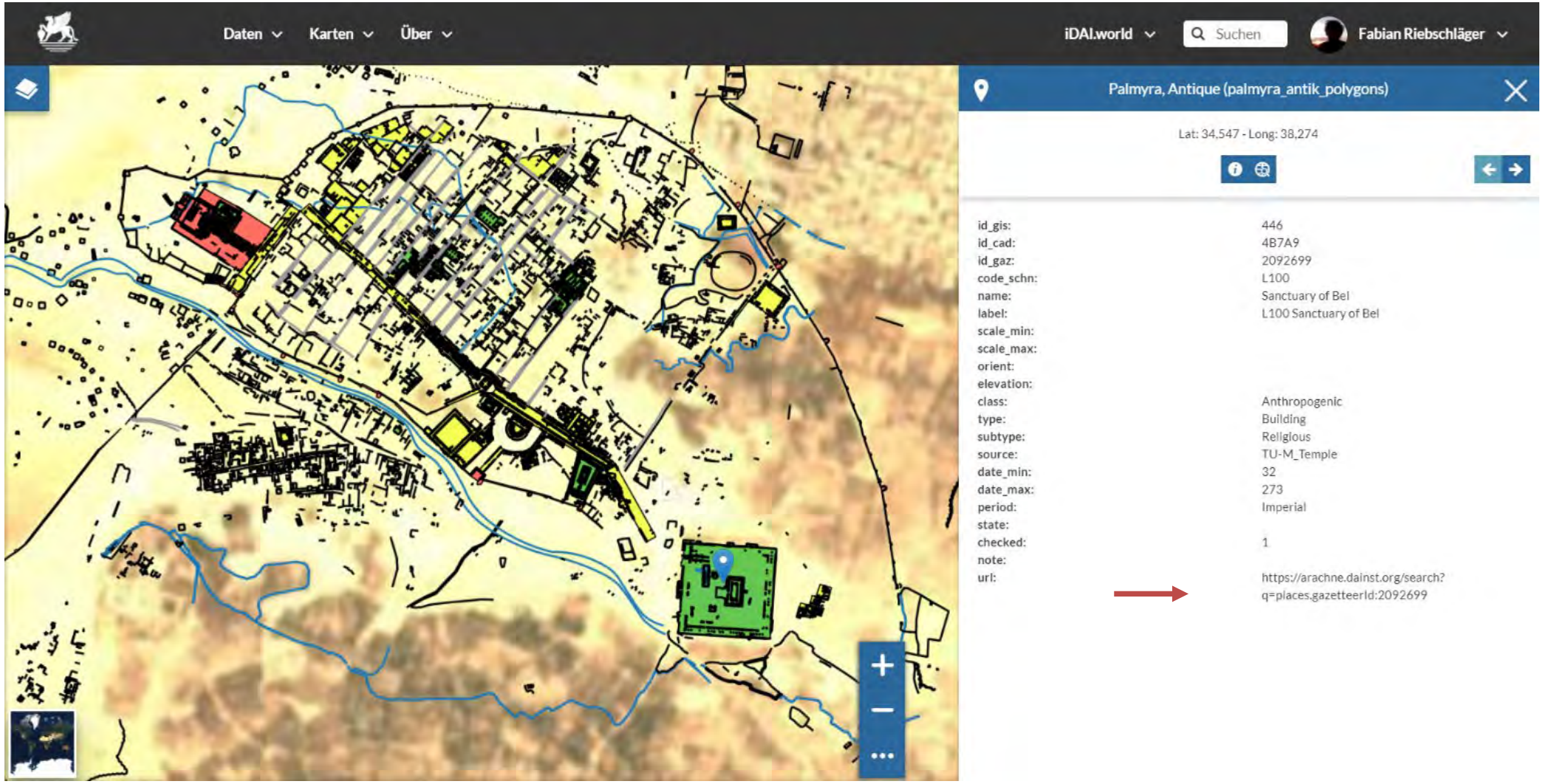
Responsible lgoldmann
Sprache English
Zusätzliche Information No information provided
Karten Ebenen WMS GetCapabilities Dokument

geoserver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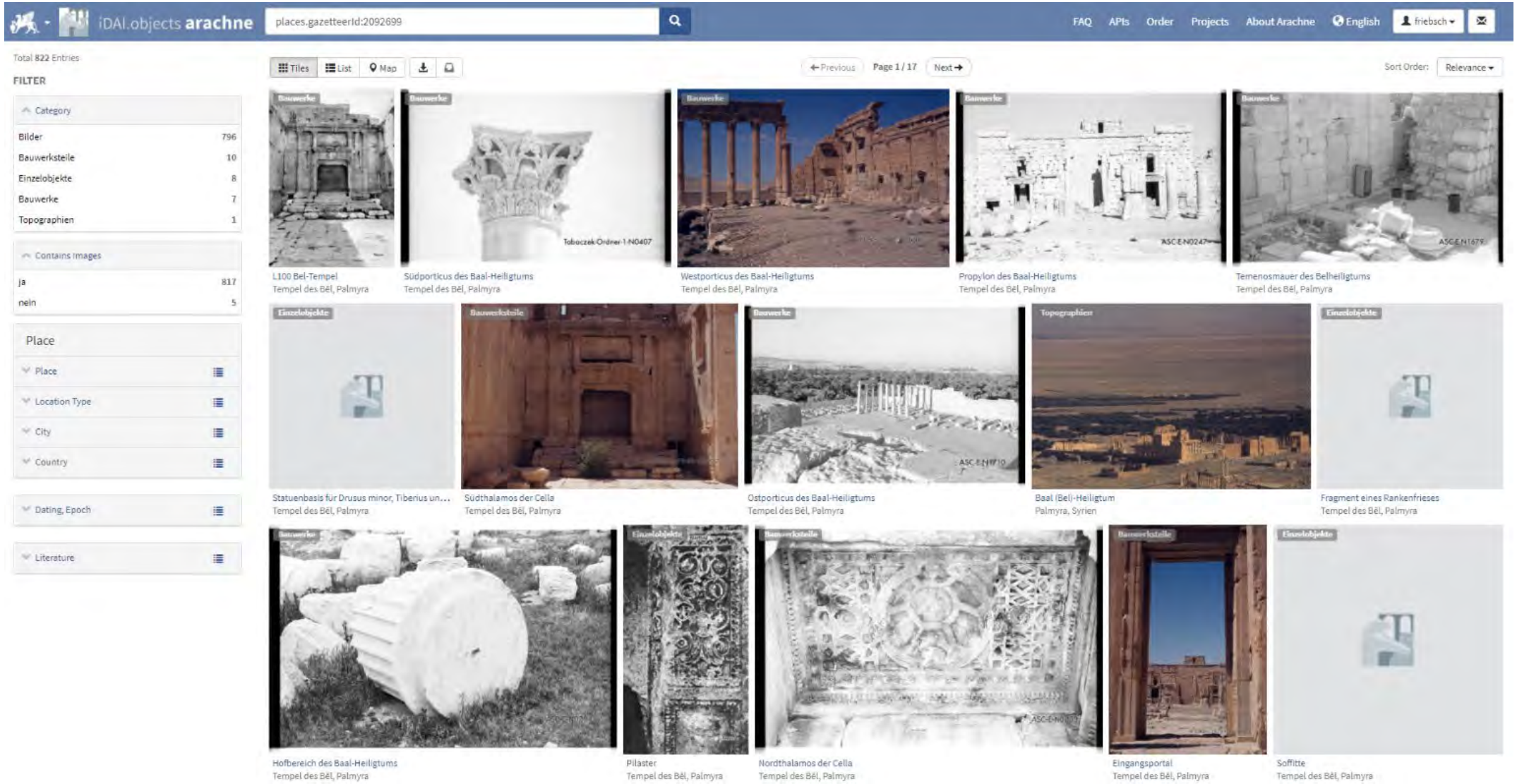
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Bearbeitung

ORTE

KATALOGE

Emagines
Emagines

Bel-Tempel - Emagines 3

Bel-Tempel - Emagines Gesamtkatalog

+ Datensatz zu Katalog hinzufügen

L100 Bel-Tempel

Tempel des Bēl, Palmyra

arachne.dainst.org/entity/8934

Entity-ID:	8934
Kategorie:	Bauwerke
Seriennummer:	2106151

Informationen zum Bauwerk

Lokalisierung

Tempel des Bēl, Palmyra, Syrien,
Art der Ortsangabe: in situ

Geographische Beschreibung

Antike Landschaft: Syrien

Römische Provinz: Syria

Kulturepoche: palmyrenisch

Datierung

Bauwerk-Baubeginn: 3. Drittel, 1. Jh. v. Chr./ nach: Freyberger

Bauwerk-Fertigstellung: (32 n. Chr.)
- Argument: Dedikation / nach: Freyberger

Charakterisierung

Gebäudetyp: Tempel

Bauordnung: korinthisch

Literatur

H. Seyring - R. Amy - E. Will, Le temple de Bel à Palmyre (1975) Zenon

K.S. Freyberger, Die frühkaiserzeitlichen Heiligtümer der Karawanenstationen im hellenisierten Osten (Mainz 1998), 74-83 Zenon

K. Schnädelbach, Topographia Palmyrena. 1 Topography, Documents d'archéologie syrienne 18 (Bonn Damaskus 2010), 26, 62, Kat.Nr. L100 Zenon

H. Seyrig – R. Amy – E. Will, Le temple de Bel à Palmyre. BAH 88 (1975), Beil. Plan 1, 2, 11, 15 Zenon

M. Al-Maqdissi, Note sur les sondages réalisés par Robert du Mesnil du Buisson dans la cour du sanctuaire de Bêl à Palmyre. Première campagne 1965 et deuxième campagne 1967, Syria 77, 155-158 (2000) Zenon

Weniger anzeigen

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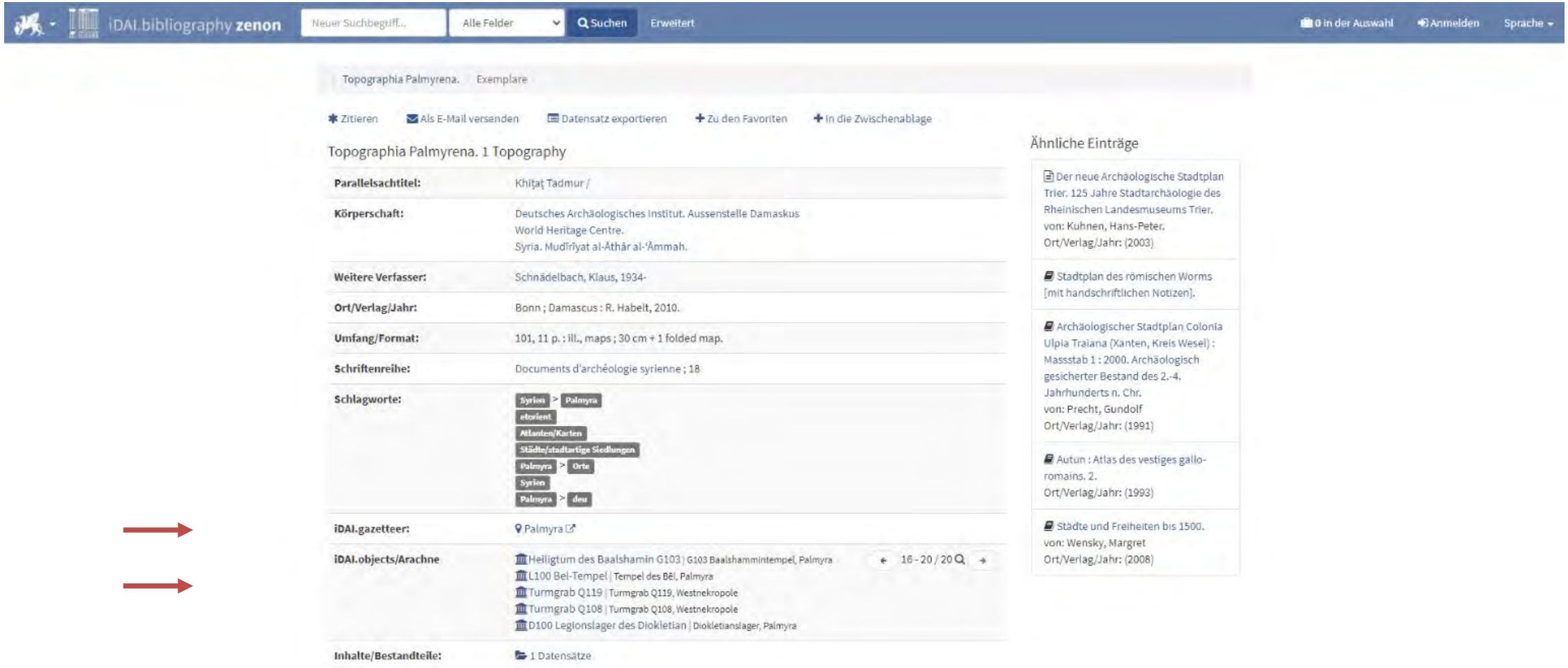

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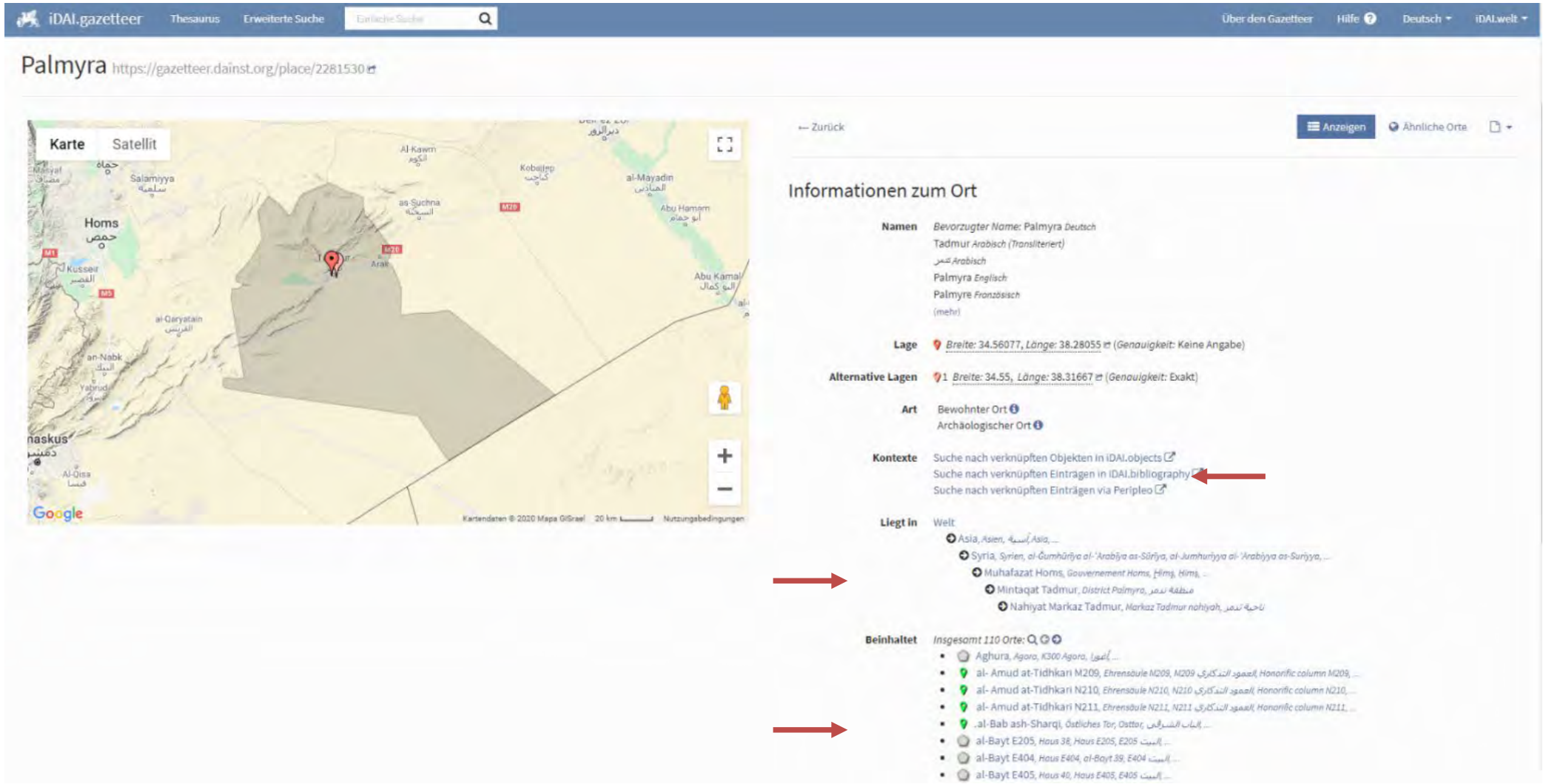
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al-Qaryatain
an-Nabk
Yabrud
Al-Qisa
Google
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← Zurück
Anzeigen
Ähnliche Orte
Informationen zum Ort
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Palmyra Englisch
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(mehr)
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Alternative Lagen
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Archäologischer Ort
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Asia, Asien, آسيا, Asia, ...
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Nahiyat Markaz Tadmur, Markaz Tadmur nahiyah, ناحية تدمر
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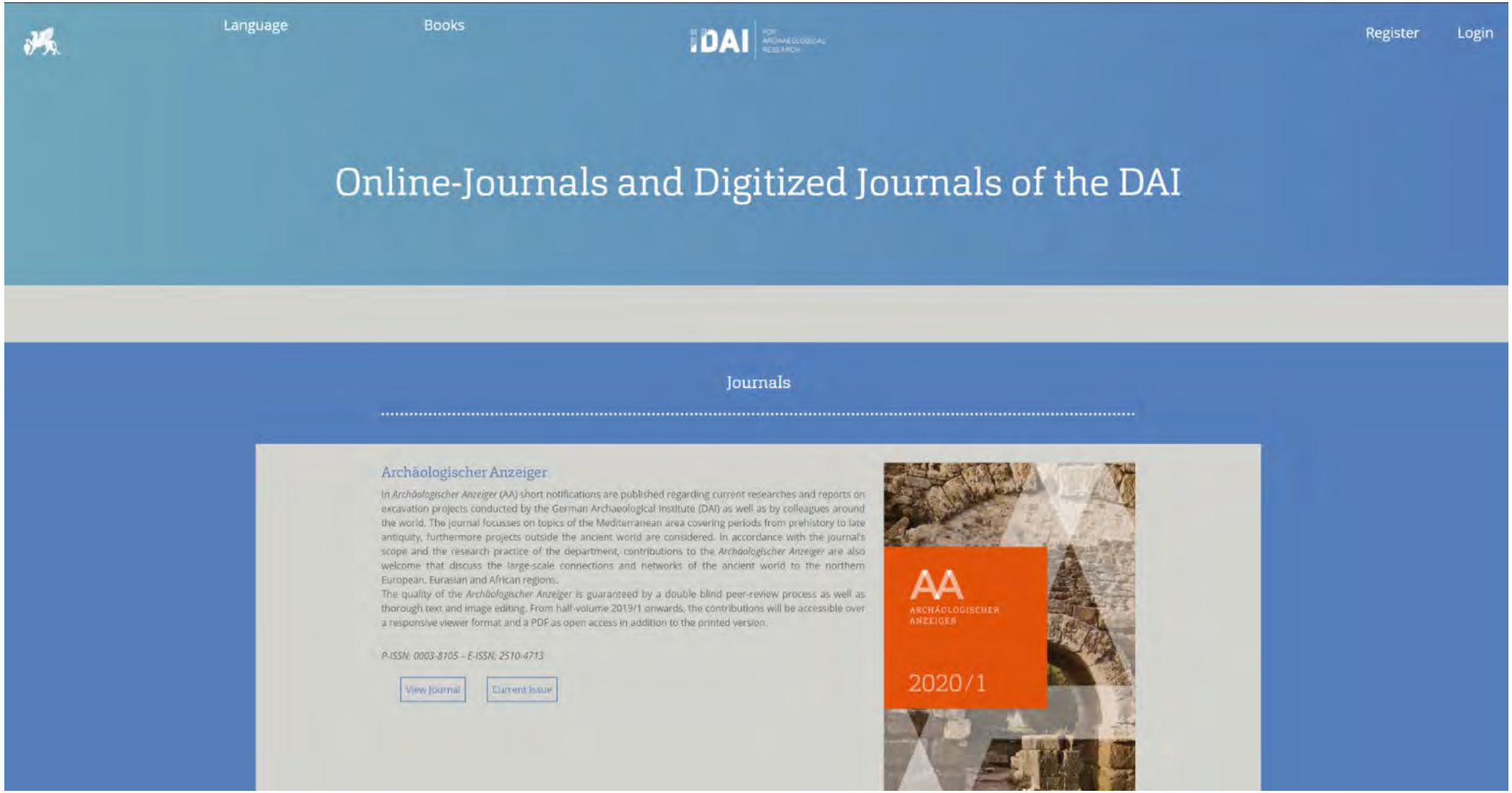

publications

JOURNAL OF GLOBAL ARCHAEOLOGY 2021

The Forgotten Kingdom

New investigations in the prehistory of Eswatini

GREGOR D. BADER, BOB FORRESTER, LISA EHLERS, ELIZABETH VELLIKY, BRANDI L. MACDONALD, JÖRG LINSTÄDTER

Introduction

1 The Kingdom of Eswatini is sandwiched between South Africa and Mozambique (Fig. 1). Physiographically, the landlocked country is subdivided into the Highveld in the west, the Middleveld in the centre, the Low Veld in the east and the narrow, elevated Lubombo Mountain range at the eastern border with Mozambique. The drop in elevation from the western Highveld to just above sea level in the east generates a wide range of ecozones in a surprisingly small geographic area.

2 Although archaeological research in neighbouring South Africa had been conducted since the beginning of the 20th century (Goodwin – van Riet Lowe 1929), Eswatini received little attention until the 1960s when Peter Beaumont conducted intensive field work there. Among the most celebrated of his sites are Castle Cavern, Banda Cavern and Lion Cavern, all situated within or around the modern Ngwenya iron ore mine (Fig. 2), originally known as Bomvu Ridge before modern mining operations started. A Middle Stone Age (MSA) radiocarbon date of 43,000 years BP came from the bottom of the archaeological sequence for Lion Cavern. Evidence for intentional ochre mining on the walls and bedrock (Fig. 3) indicated Lion Cavern to potentially be the oldest ochre mine in the world (Dart – Beaumont 1971; Boshier – Beaumont 1972).

3 The Ngwenya sites are the tip of the iceberg in archaeological terms. Between 1965 and 1967, Beaumont investigated more than 100 archaeological sites in Eswatini and excavated several of them. These demonstrated the deep history of hominin occupations spanning the Early Stone Age to the Iron Age (Beaumont's field notes). However, very little of his work ever reached the public. After the early 1970s, Beaumont left Eswatini and started excavations at Border Cave (Beaumont 1978). As a consequence no archaeological excavations where conducted at Eswatini anymore and the country faded away from archaeological prominence.

4 David Price Williams rediscovered the archaeological potential of Eswatini by chance. Coming from Britain – and married to a Swazi – he met her family for the first time on a Christmas holiday visit to Eswatini during the mid-seventies (Price Williams 2016). After a visit to the Nsangwini rock art site, Price Williams fell in love with the country. He established the Swaziland Archaeological Research Association (SARA) and spent three to four months in Eswatini every southern hemisphere winter, along with his family. For more than a decade, Price Williams conducted exemplary research in Eswatini, using modern excavation techniques on an innovative and interdisciplinary scale.

5 Among the most famous excavated sites are Sibebe (Price Williams 1981), Siphiso and Nyonyane (Barham 1989a; Barham 1989b) (Fig. 1). As we found out recently though, by going through his collections in the National Museum, he documented and excavated more than 80 archaeological sites. Some of these were recorded in Beaumont's time, while others were completely new. However, when Price Williams left Eswatini in 1989, the majority of them remained unstudied or unpublished. The large SARA collection remained stored in the Eswatini National Museum at Lobamba, unseen by the archaeological community. Once again, Eswatini was forgotten, this time for 27 years. This is particularly astonishing as Stone Age research in neighbouring South Africa was flourishing at that time.

Objectives

6 In 2016, our team started a new project in Eswatini. The primary objective was to screen the SARA collections, evaluate the quality of their documentation, and survey the country for new research opportunities. After the first campaign, we were overwhelmed by the possibilities. We began with a comprehensive, digital inventory of the Price Williams collection and conducted field surveys. Soon, our interest in the ancient mining activities at

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mining at Lion Cavern however could be even older, reaching beyond the C^{14} limit. Furthermore, the publications containing the old dates lacked any illustrations or descriptions of the mining associated archaeological assemblages, apart from Beaumont's note of "mining tools" (Dart – Beaumont 1971).

7 On a broader scale, the presence of Ngwenya as a high-quality ochre source made us curious to find out more about the red earth pigment. Ochre plays a major role in Stone Age research in southern Africa due to its duality in meaning covering both functional and symbolic aspects. The earliest intentional use is documented from Twin Rivers in Zambia dating back between 350,000 and 195,000 BP (Barham 1998; Barham 2002). Since than ochre use is evident throughout the MSA, Later Stone Age (LSA) up to the Iron Age (IA) and into modern times. The well-known geometric engravings on an ochre piece from Blombos cave dating to the Still Bay (Henshilwood et al. 2001) were interpreted as one of the earliest expressions of symbolism. Among others, the use of ochre and symbolism was associated with the origins of language (Watts 2009). However, ochre might have had functional value as well. Some researchers indicated that ochre powder could have been used as sunscreen (Rifkin et al. 2015) or for tanning animal hides (Rifkin 2011). Furthermore, ochre was also tested to be highly effective as a loading agent in mastics (Wadley 2005; Wadley – Williamson – Lombard 2004; Wadley – Hodgskiss – Grant 2009). However, apart from few published results from South Africa (e.g. Dayet et al. 2016) we know little about the procurement strategies and transport distances of the red earth pigment. Lion Cavern and Eswatini in general thus would play a crucial role for the investigation of these aspects.

8 In 2019, a project funded by the Deutsche Forschungsgemeinschaft (DFG - BA 6479/2-1) was awarded to us to test Lion Cavern for remaining archaeological deposits. We decided to excavate the site and collect new dating samples. Simultaneously, we decided to conduct a broad scale geochemical ochre tracing project in the country using neutron activation analysis and inductively coupled plasma-mass spectrometry on both archaeological and geological samples from Ngwenya and other sources of ochre in the region.

Preliminary results

9 We were able to detect a 4 m intact archaeological sequence at Lion Cavern which had been exposed by modern mining activities in the 1970s (Fig. 4). Although chances are high that this profile is connected to Beaumont's excavation area, we cannot be sure at the moment due to massive loads of rubble in between. Therefore, we call this provisionally Lion Cavern II (LCII). At the bottom of the sequence from LCII typical MSA tools are eroding out of the profile (Fig. 5).

10 We took four sediment samples for optically stimulated luminescence dating in equal distances from top to bottom which are currently under examination at the Cologne Luminescence Laboratory. Higher above LCII we found another cavity filled with sediments which we call Lion Cavern III (LCIII) (Fig. 2). In the profile of LCIII we found two overlying bands of charcoal which were dated to 12,556 – 12,400 (BETA - 541999) and 12,160 – 11,940 cal BP (BETA - 541998) indicating that this part of the mine was used during the Late Pleistocene LSA. For the ochre tracing project, we selected 346 ochre pieces out of the collections from Sibebe, Siphiso, Nyonyane, Mlawula I & II and Nsangwini (Fig. 6). For the geological comparative collection, we systematically collected several dozen samples from Lion Cavern and across the extensive Ngwenya iron deposit, and another two dozen from two newly discovered [redacted] at Bulembu and Figg's Peak. The provenance analysis is currently underway at the Archaeometry Laboratory at the University of Missouri. Preliminary results suggest though that the geological sources of ochre that we sampled are highly distinct and can be linked with large confidence to archaeological pieces.

Future perspectives

11 Our research at Lion Cavern and on ochre provenance is only the beginning of a long-term project in Eswatini focusing on questions of cultural evolution and modern human behaviour on a timeline from the MSA to the Iron Age. With the help of Bob Forrester, who spent a significant amount of time with John Masson surveying the country, we know of about 100 archaeological sites, many of them with rock art and archaeological deposits. Together with our colleagues from the Eswatini National Trust Commission (ENTC) we will intensify our research on the old Price Williams collection and conduct new excavations at Lion Cavern and at other selected sites in different parts of the country. We hope to fill gaps of knowledge about the history of ancient human behaviour in this part of Africa.

Bulembu

Name: Bulembu
Location: Latitude: -25.95, Longitude: 31.133333
Link to iDAI.world: https://gazetteer.dainst.org/place/2769311

Figg's Peak

Name: Figgs Peak
Location: Latitude: -25.959444, Longitude: 31.248611
Link to iDAI.world: https://gazetteer.dainst.org/place/2769312

publications

AA ARCHÄOLOGISCHER ANZEIGER

Die Ausgrabungen in Boğazköy-Ḫattuša 2018

ANDREAS SCHACHNER

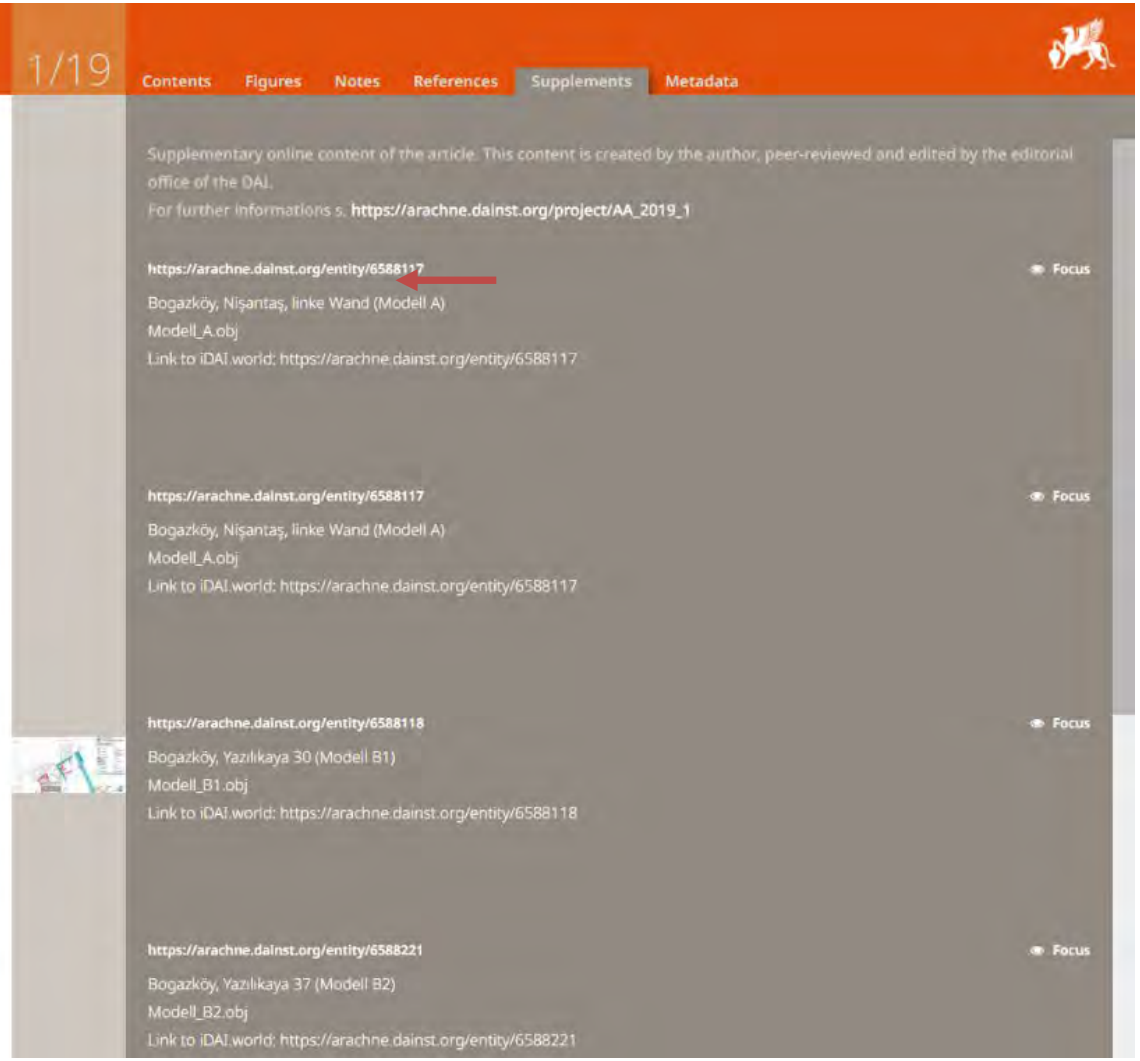
G. Barjamovic, N. Bolatti Guzzo, M. A. Berge, M. Drahor, T. Haller, D. Krüger, S. Kühn, M. Marazzi, A. Ongar, C. Pepe, L. Repola, D. Schwemer, O. Soysal, Ö. Sümer, S. Tilia

Die Arbeiten im hethitischen Stadtgebiet

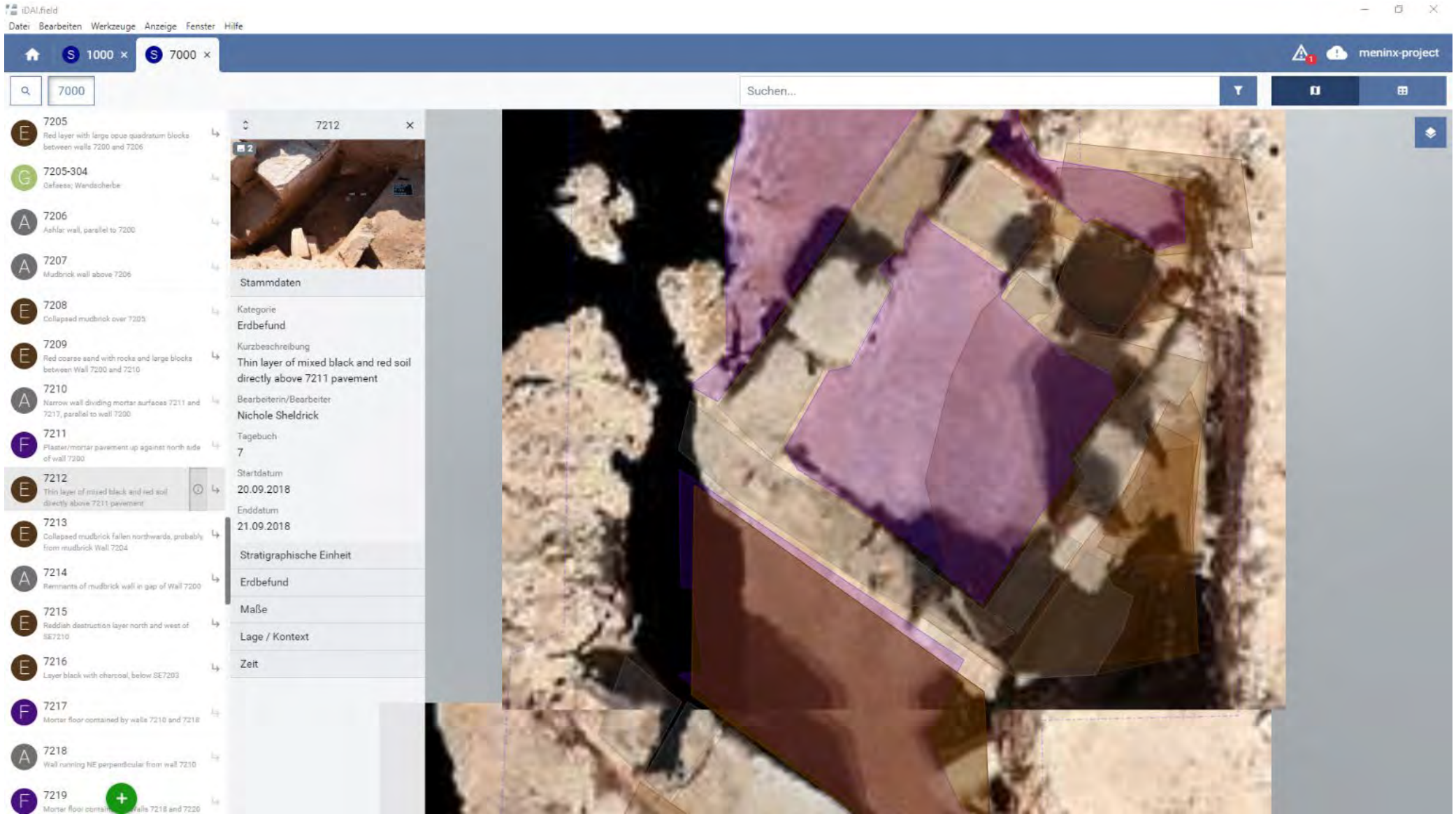
Ausgrabungen in der nördlichen Unterstadt

1 2018 wurden die Arbeiten in der nördlichen Unterstadt mit dem Ziel fortgesetzt, die chronologische und städtebauliche Entwicklung dieses Stadtgebiets im Vergleich zu den bekannten Teilen der Altstadt weiter zu erforschen. Aufbauend auf den bisherigen Arbeiten [1] stand zunächst die Klärung der verbliebenen Bereiche eines monumentalen Gebäudes der hethitischen Phase im Fokus. Allerdings erbrachten die Grabungen in diesem Zusammenhang auch unerwartete Ergebnisse, die neue Einblicke nicht nur in die Struktur der hethitischen, sondern vor allem auch der *kārum*-zeitlichen Stadt ermöglichen (Abb. 1).

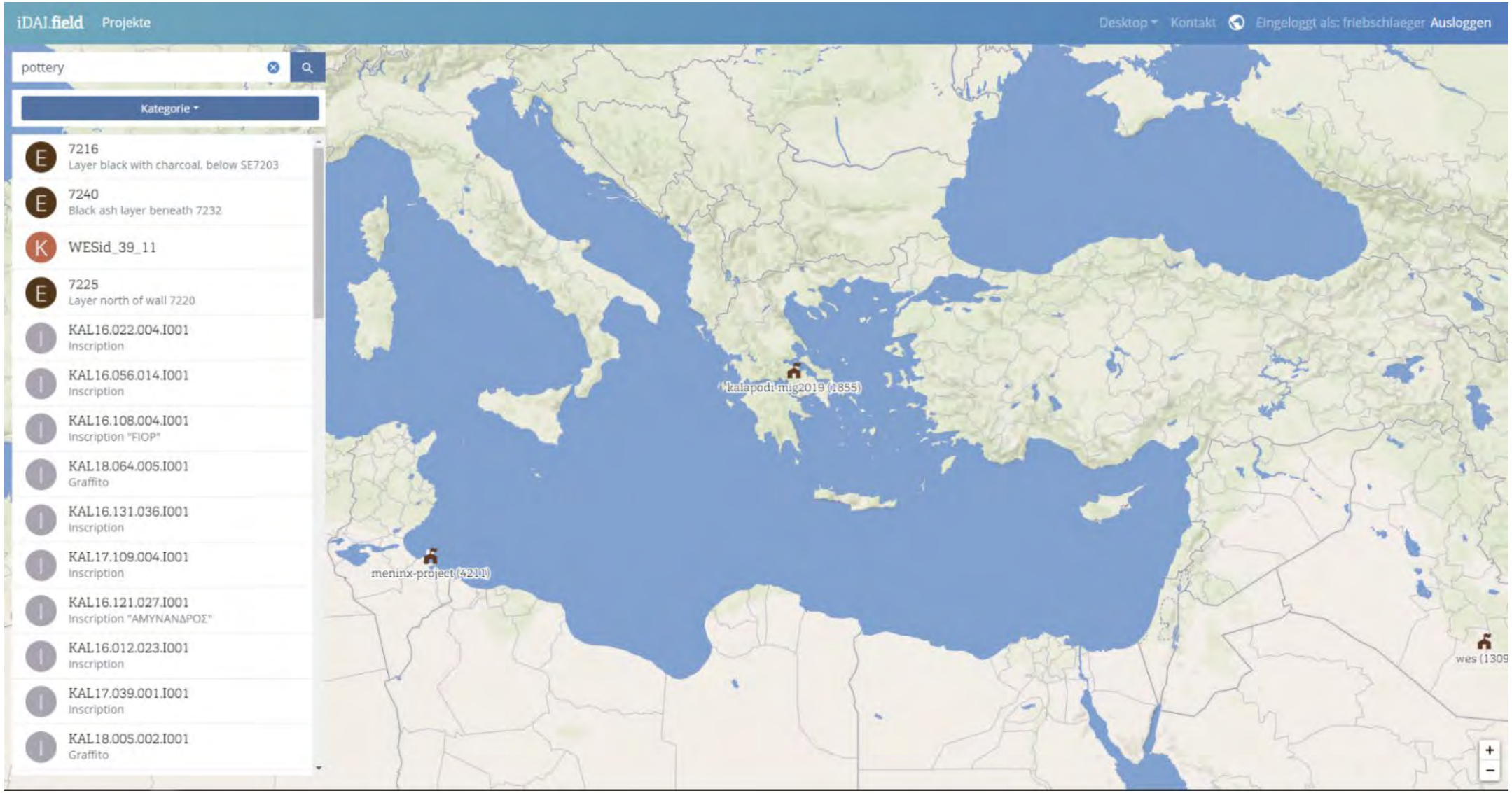
2 Sowohl im Süden als auch im Norden des monumentalen hethitischen Gebäudes konnten weitere Teile der *kārum*-zeitlichen Bebauung freigelegt werden. Während die Mauerzüge im Süden des Areals möglicherweise eine Einheit bilden, können zwei weitere Räume im Norden nicht unmittelbar angeschlossen werden (Abb. 1). Da alle Mauern dieser einzigen *kārum*-zeitlichen Bauschicht auf dem gewachsenen Boden errichtet und unmittelbar von den hethitischen Mauern überbaut wurden, sprechen die stratigraphischen Beobachtungen neben den C^{14}-Datierungen dafür [2], deren Erbauung als gleichzeitig anzusehen. Die einheitlichen Brandspuren deuten im Moment daraufhin, daß es sich ebenfalls um ein Ereignis handelt, ohne jedoch dieses datieren oder seine Ursache benennen zu können.

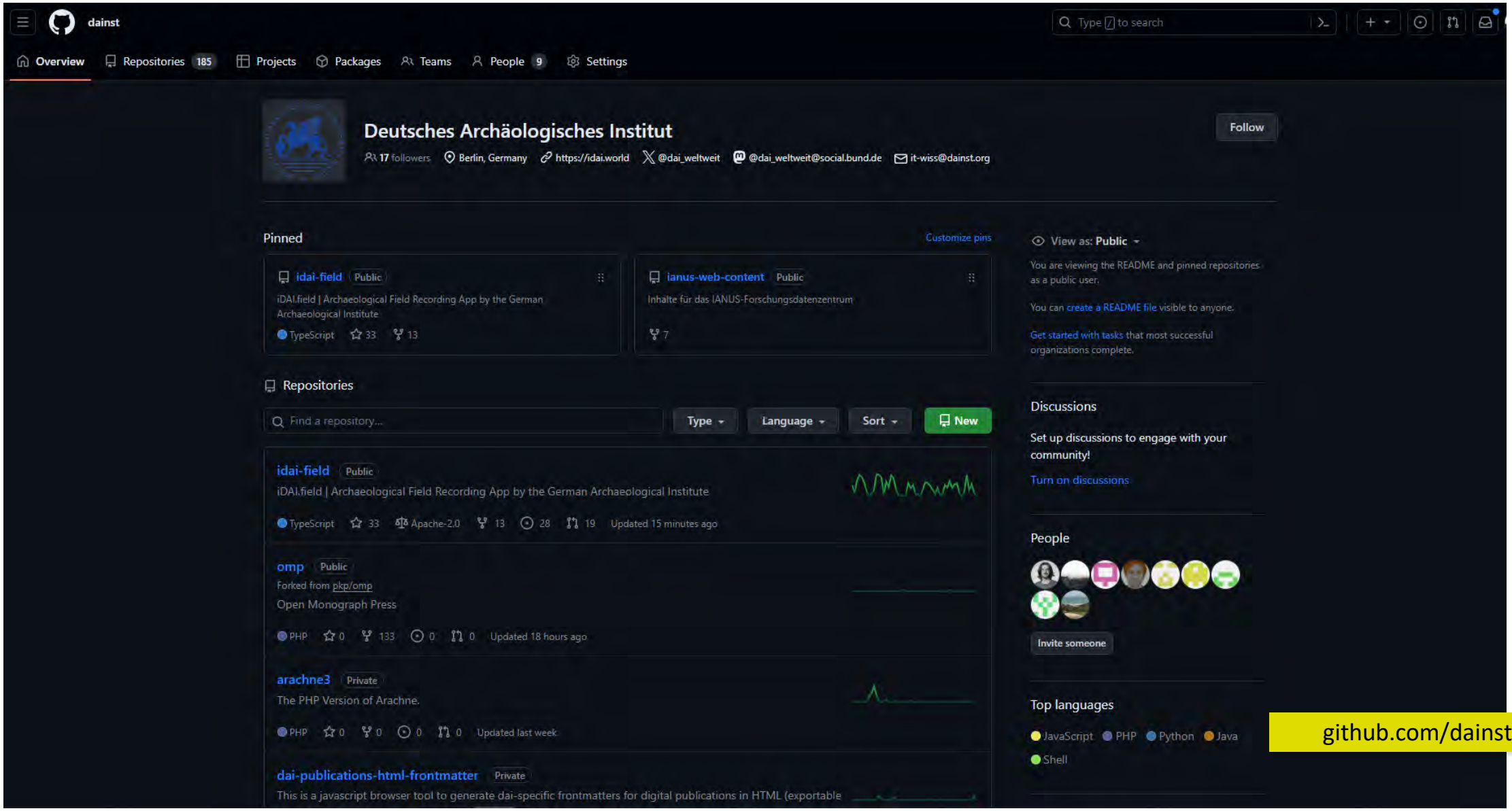


field


iDAI.field
Datei Bearbeiten Werkzeuge Anzeige Fenster Hilfe
1000
7000
meninx-project
7000
Suchen...
7205
Red layer with large opus quadratum blocks between walls 7200 and 7206
7205-304
Gefäess; Wandscherbe
7206
Ashlar wall, parallel to 7200
7207
Mudbrick wall above 7206
7208
Collapsed mudbrick over 7205
7209
Red coarse sand with rocks and large blocks between Wall 7200 and 7210
7210
Narrow wall dividing mortar surfaces 7211 and 7217, parallel to wall 7200
7211
Plaster/mortar pavement up against north side of wall 7200
7212
Thin layer of mixed black and red soil directly above 7211 pavement
7213
Collapsed mudbrick fallen northwards, probably from mudbrick Wall 7204
7214
Remnants of mudbrick wall in gap of Wall 7200
7215
Reddish destruction layer north and west of SE7210
7216
Layer black with charcoal, below SE7203
7217
Mortar floor contained by walls 7210 and 7218
7218
Wall running NE perpendicular from wall 7210
7219
7212
Stammdaten
Kategorie
Erdbefund
Kurzbeschreibung
Thin layer of mixed black and red soil directly above 7211 pavement
Bearbeiterin/Bearbeiter
Nichole Sheldrick
Tagebuch
7
Startdatum
20.09.2018
Enddatum
21.09.2018
Stratigraphische Einheit
Erdbefund
Maße
Lage / Kontext
Zeit

field


iDAI.field
Projekte
Desktop
Kontakt
Eingeloggt als: friebschlaeger
Ausloggen
pottery
Kategorie
7216
Layer black with charcoal, below SE7203
7240
Black ash layer beneath 7232
WESid_39_11
7225
Layer north of wall 7220
KAL16.022.004.I001
Inscription
KAL16.056.014.I001
Inscription
KAL16.108.004.I001
Inscription "ΓΙΟΡ"
KAL18.064.005.I001
Graffito
KAL16.131.036.I001
Inscription
KAL17.109.004.I001
Inscription
KAL16.121.027.I001
Inscription "ΑΜΥΝΑΝΔΡΟΣ"
KAL16.012.023.I001
Inscription
KAL17.039.001.I001
Inscription
KAL18.005.002.I001
Graffito
kalapodi-mig2019 (1855)
menirx-project (4211)
wes (1309



github.com/dainst

Thank you for your attention

Fabian.Riebschlaeger@dainst.de

Corporate Design und Konzeption und Gestaltung der iDAI.world Grafiken und DAI Homepage:
LMK-Büro für Kommunikationsdesign
Tanja Lemke-Mahdavi

SciLake: Assisting domain-specific applications on top of open SKGs The OpenAIRE Graph use-case

Paolo Manghi
OpenAIRE AMKE
ISTI - Consiglio Nazionale delle Ricerche

Workshop on Towards Open Digital Research Ecosystems
Open Science Forum

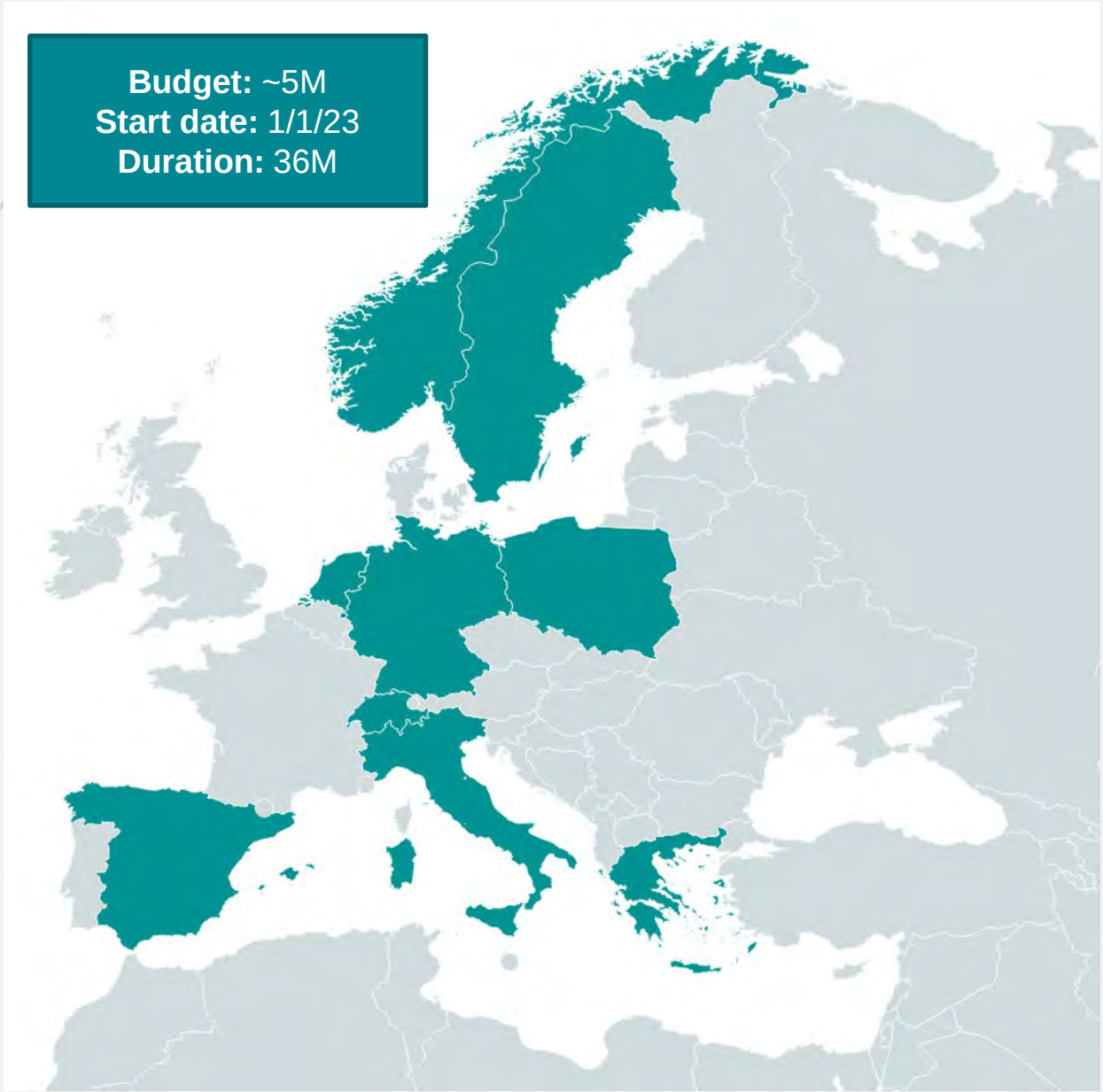
14th of February, 2024

Funded by the European Union Supporting eosc

The slides are co-authored by Thanasis Vergoulis, OpenAIRE AMKE & ATHENA RC

Scilake

Budget: ~5M
Start date: 1/1/23
Duration: 36M



Map created from https://www.mapchart.net

9 countries / 13 organisations

ATHENA Research & Innovation Information Technologies
OpenAIRE
icm
Uniwersytet Warszawski
Consiglio Nazionale delle Ricerche
DFKI
Hes·so
CERTH Centre for Research & Technology Hellas
SIRIS Academic
TU/e Eindhoven University of Technology
ICCS
Karolinska Institutet
University of Oslo
Opix Data Driven Insights

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Scientific Knowledge Graphs

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Scilake

ORCID

Crossref

DataCite
FIND, ACCESS, AND REUSE DATA

OpenAIRE Graph

Europe PubMed Central

OpenCitations

PubMed

ORKG

OpenAlex

ROR

Semantic Scholar

Microsoft Academic

LENS.ORG
Solving The Problem Of Problem Solving™

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Domain specific SKGs

Nodes of the SKG

Metadata

- Publications
- Research Data
- Research Software
- Context → Domain elements (e.g. concepts, vocabolaries)
- Domain entities (e.g. proteins)

Edges of the SKG

Semantic links

- Domain entities (e.g. proteins)
- Cites
- hasAffiliation
- VersionOf
- ...

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Objective

Combining domain and domain-agnostic **SKGs** and leveraging them to build **added-value services** that are **tailored for a particular domain** of interest

- Discovery
- Reproducibility
- Research assessment

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Challenges

- **Heterogeneous formats**: unstructured files (e.g., textual data), databases and knowledge bases.
- **Non-English** texts are common in some domains
- **Diverse technical expertise** (e.g., graph & text mining) from domain-specific experts may be different or missing at different SKG sites
- **Lack of interoperability:** SKGs adopt different models also for the same entities
- **Scope:** domain-agnostic SKGs cannot cope with domain-specific idiosyncrasies

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SciLake: the Vision

- Introducing an **open, transparent & customizable Scientific-Lake-as-a-Service**
  - Data lake **hosting domain-specific & domain-agnostic SKGs**
  - Facilitates sharing of **tools for SKG enrichment**
  - Facilitates the **creation of community-created SKGs** out of tools and other SKGs in the DataLake
  - Offers a **unified way to access & query** the contained assets.
- Two **discipline-tailored, added-value services** to facilitate:
  - **navigating** the respective vast knowledge space (exploiting indicators of **scientific impact**)
  - improving **research reproducibility** in the respective domain
- Customise, test & demonstrate the developed services in **real-world pilots**.

Pilot 1: Neuroscience

Pilot 2: Cancer research

Pilot 3: Transportation research

Pilot 4: Energy research

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The Concept at a Glance

Scilake

domain knowledge

expert

Scientific Lake

Import & Transformation Modules

OpenAIRE Graph

domain-specific SKG

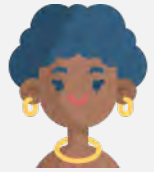
Data Access & Querying Modules

Added-value services

Knowledge discovery assisted by impact indicators services

Reproducibility assistance services

researchers



- Web crawler & scrapper
- Text mining tool
- Link recommendation tool
- Machine translation tool
- SKG creation assistant
- SKG curation tool

- SKG catalogue
- SKG querying engine & database
- SKG-IF compatible APIs

- Fields/Topics extraction & evolution
- Impact indicator calculation & propagation/aggregation
- Impact-based exploration & analysis

- Research object identification in text
- Research objects link recommendation
- Reproducibility indicators calculation

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Icons created by ultimatearm, Becris and Freepik from www.flaticon.com.

OpenAIRE Graph in SciLake

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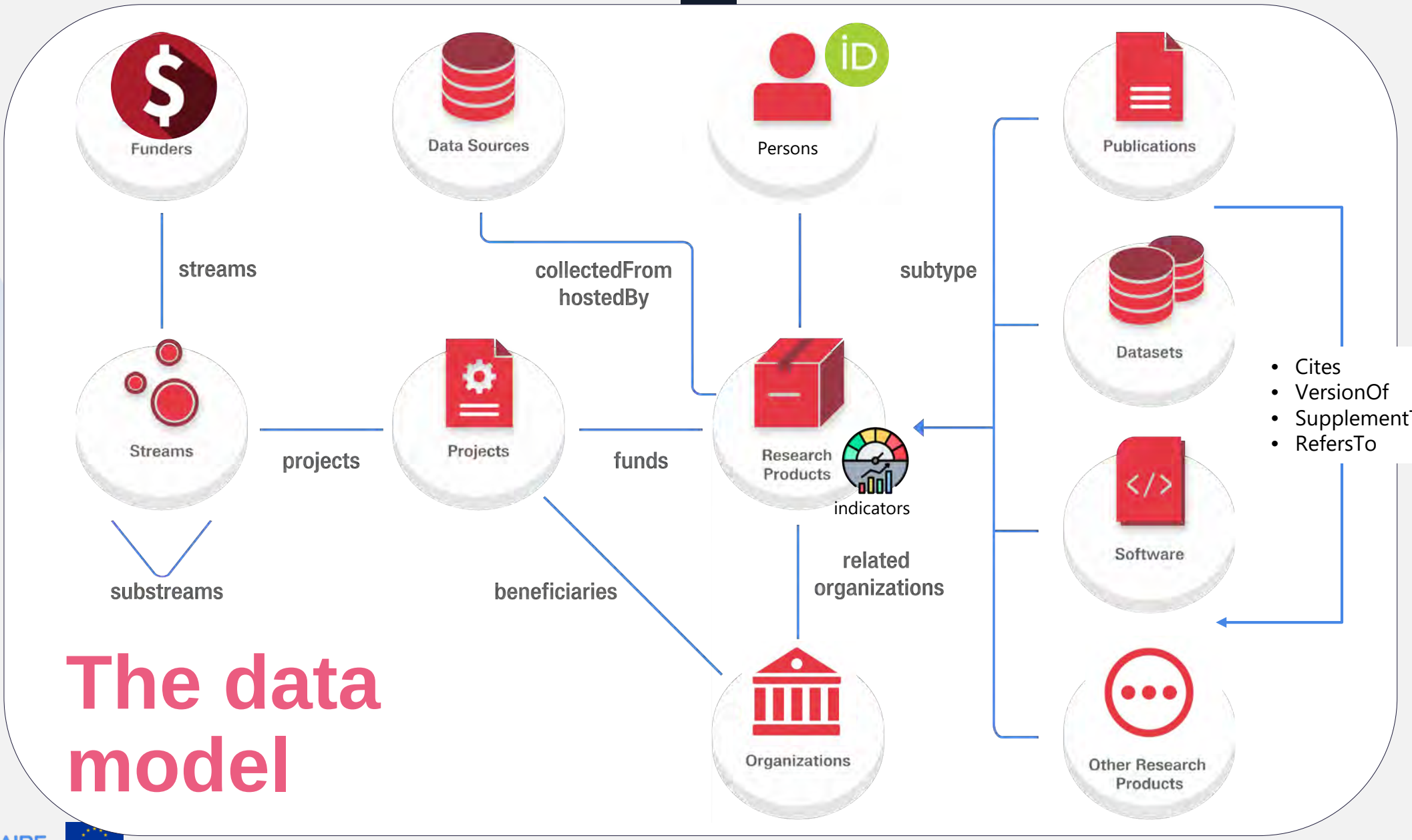

The data model

Data model features

Embeds bibliometrics such as APCs (from OpenAPC), COUNTER metrics (from OpenAIRE UsageCounts), popularity (from BIP!), and citation counts (OpenCitations)

Persistent identifiers include today DOI, ArXiv, PubMed, Handles for *publications;* DOI, accession numbers, handles for *research data;* DOI, handles, and software heritage IDs for *research software* (the data model can flexibly include any PID schema!)

Generates stable identifiers using a combination of stateless identifiers and internal status

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Data sources contributing to the Graph

… and more **tools and software sources**

… and more **publishers**

… and more **European and international funders**

… and more **research s**

… and more **registries**

… and more **aggregators**

… and more **thematic and institutional repositories**

… and more **einfra and RI sources**

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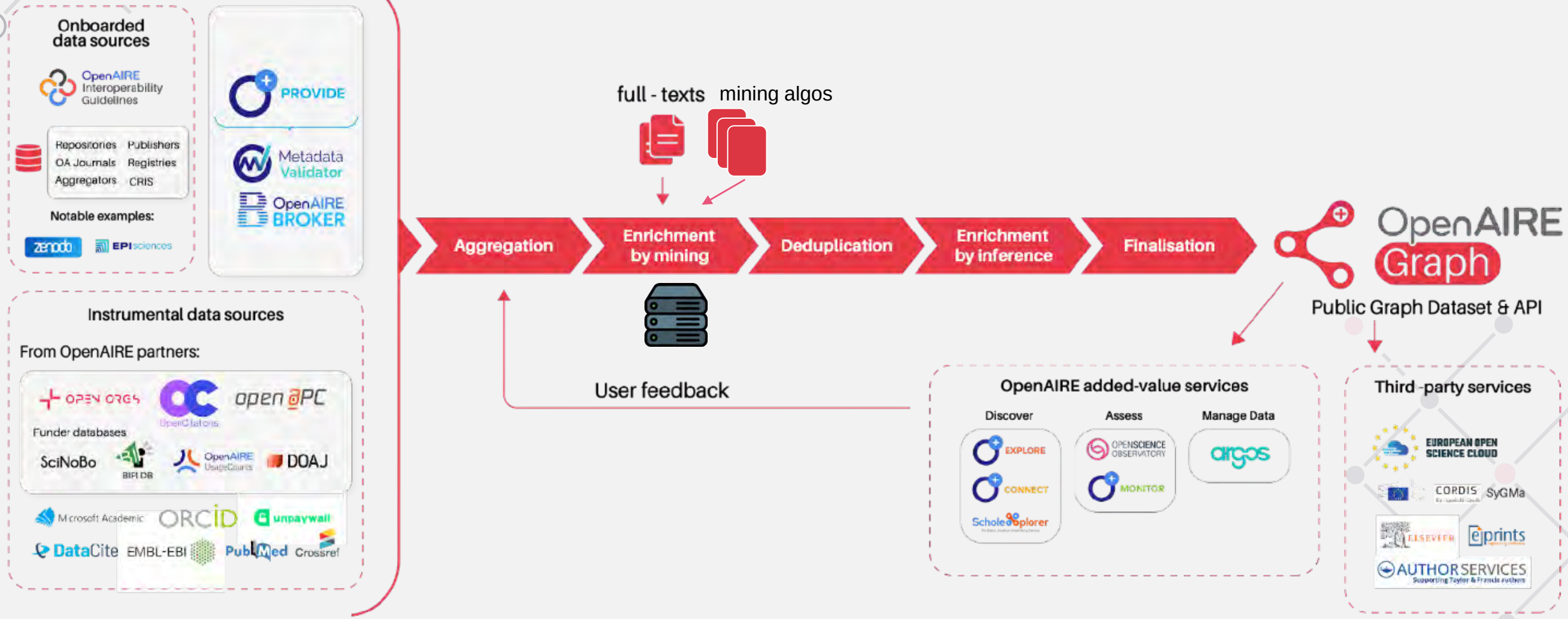
Data provision chain: full-text mining



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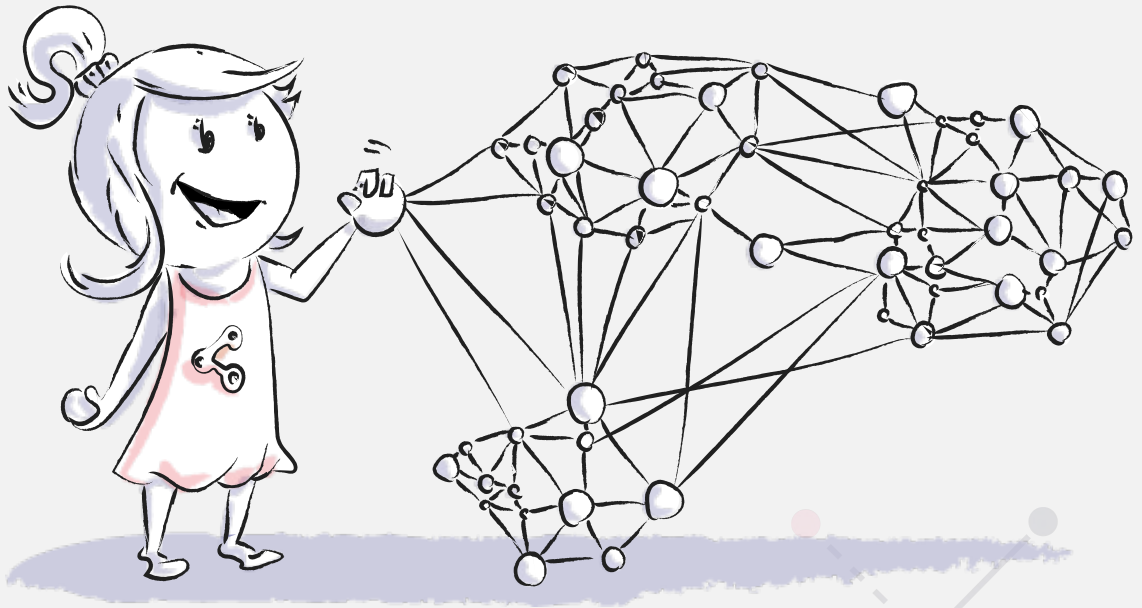
OpenAIRE Graph in numbers

(Jan, 2024)

- 173Mi publications
- 398k software
- 60Mi research data
- 8Mi other research products
- 168 funders (30 with projects)
- 3.4Mi grants
- 203K organizations



OpenAIRE Graph

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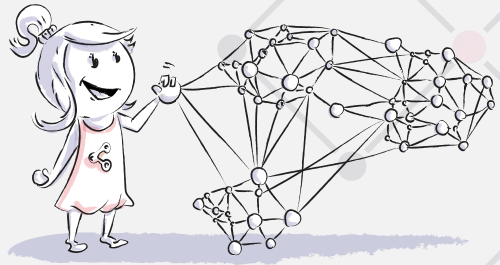
OpenAIRE Graph in numbers

(Jan, 2024)

- **Links from pubs to products**
  - 1.96Bi pubs-pubs links (citations)
  - 78Mi pubs-data links
  - 396K pubs-software links
- **Links to grants**
  - 4.9Mi pubs-grant links
  - 900K data-grant links
  - 17K pubs-grant links
- **Affiliations**
  - 142Mi pubs-organization links (affiliations)
  - 1.2Mi data-organization links (affiliations)
  - 800K software-organization links (affiliations)
- 245Mi pubs-FoS (36Mi pubs with FoS)



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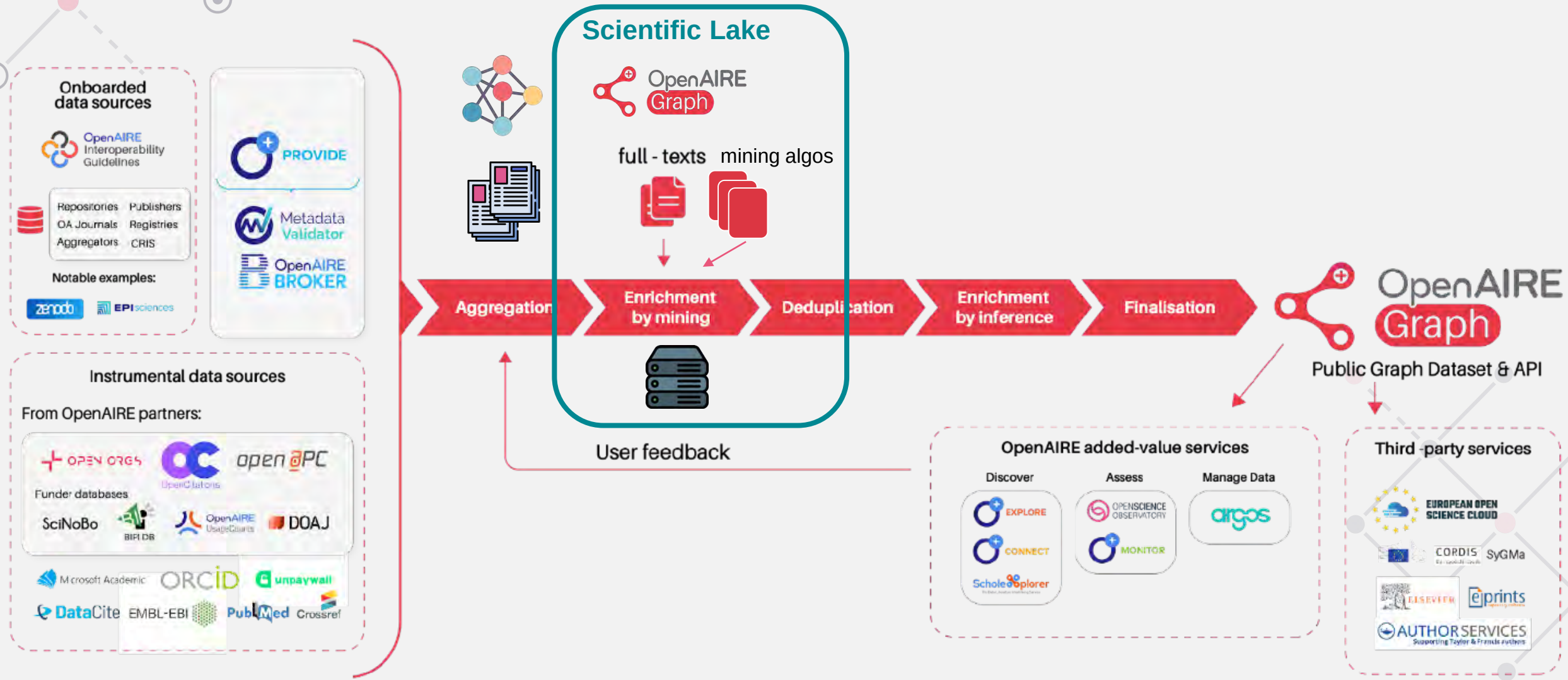
OpenAIRE Graph in SciLake



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Scilake

Contact us

Thank you

Email: **paolo.manghi@openaire.eu**

Twitter/X: **@paolomanghi** / **@Scilake_project**

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