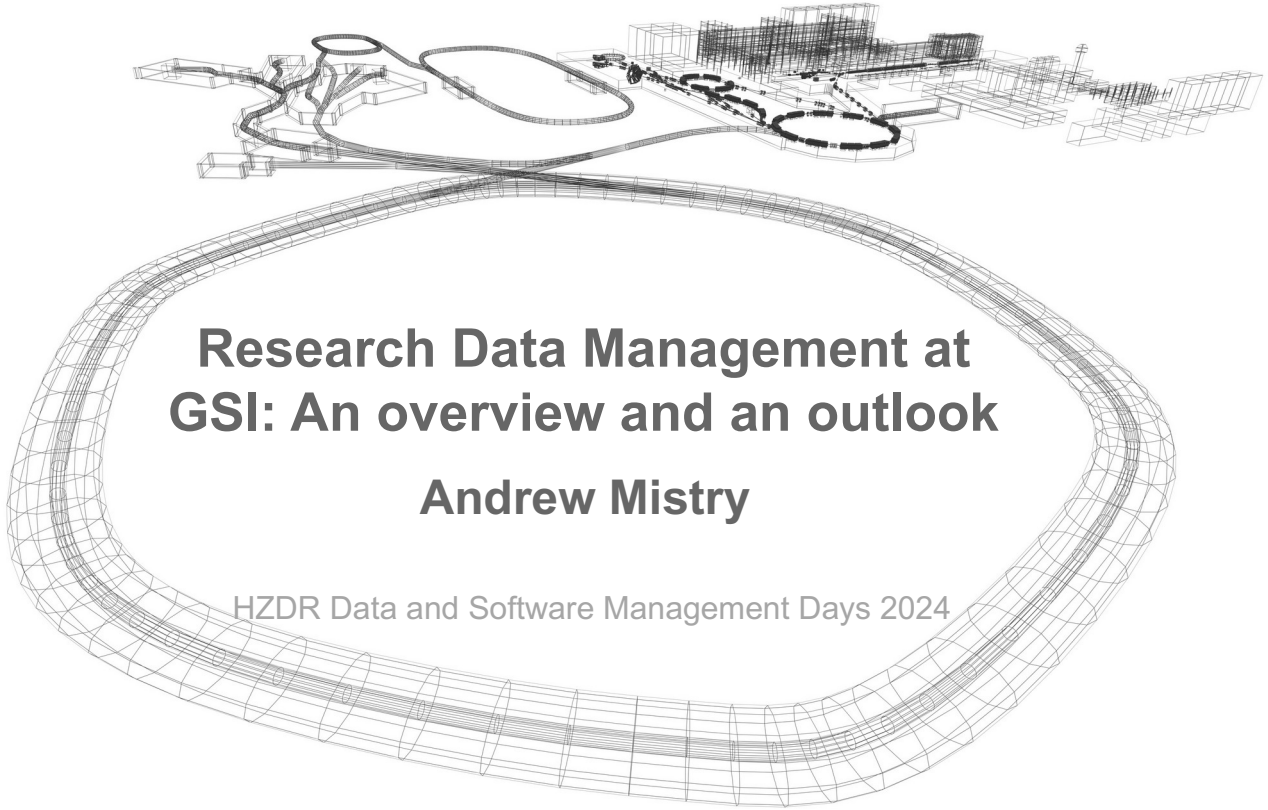
HELMHOLTZ
RESEARCH FOR GRAND CHALLENGES

FAIR GSI



Research Data Management at GSI: An overview and an outlook

Andrew Mistry

HZDR Data and Software Management Days 2024

GSI Helmholtz Centre for Heavy-ion Research

Heavy-ion accelerator laboratory in Darmstadt, Germany with 1350+ employees & 700 external users

Who we are?

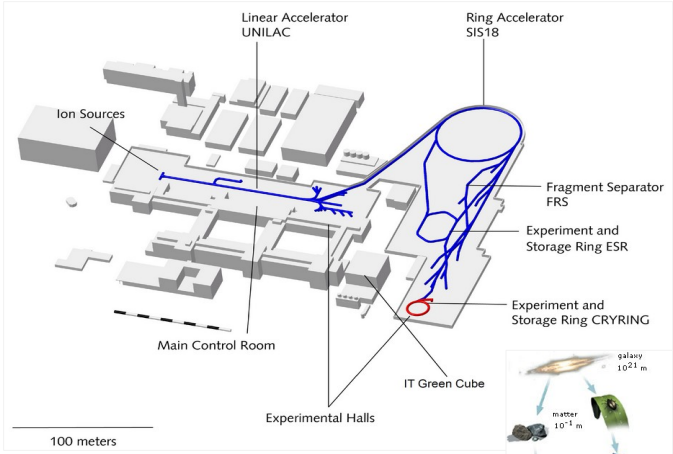
- Founded in **1969**
- **Elements H to U can be accelerated**

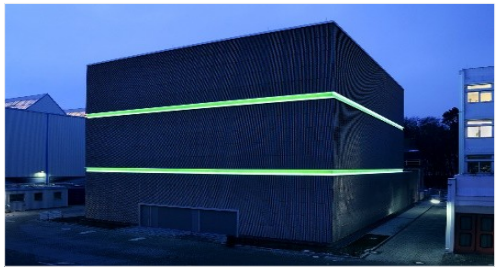
Past Achievements

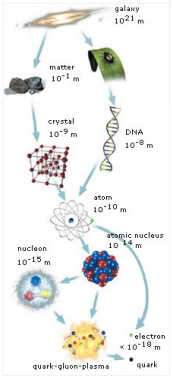
- Discovering **six new elements**, **many exotic nuclei**
- Developing **a new cancer treatment**

Our Future

- First stage injector for the **FAIR facility**
- **Experiments continuing** (FAIR Phase-0)







Research Interests

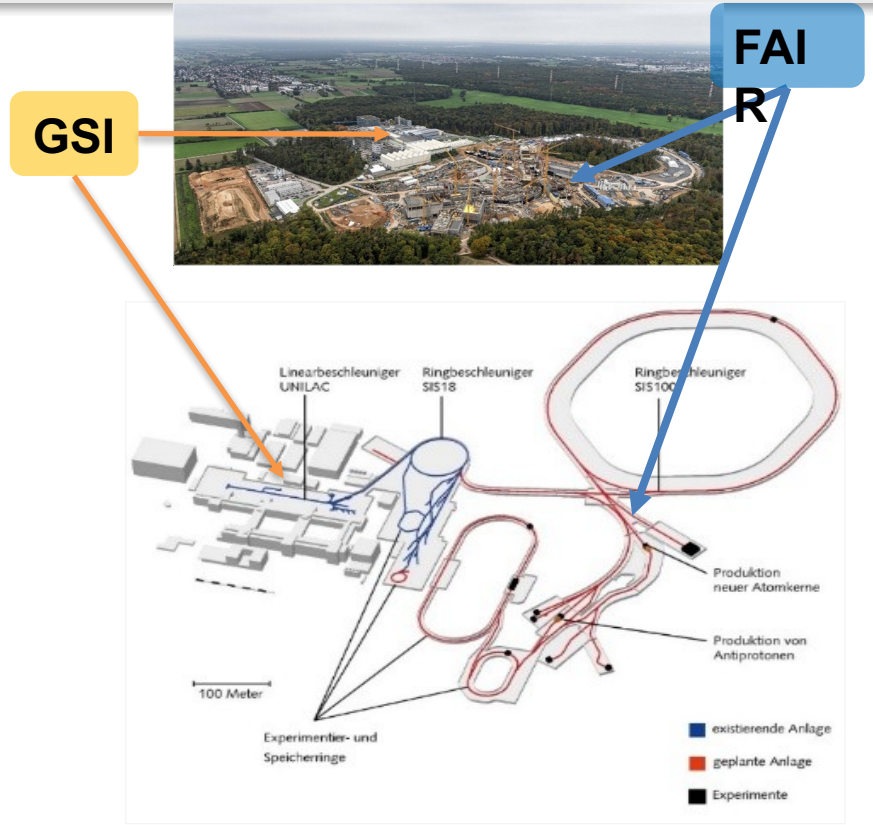
- Accelerator Physics
- Detector Development
- Atomic Physics
- Nuclear and particle Physics
- Plasma Physics
- Biophysics
- Materials Research
- High-Performance Computing
- Theoretical Physics

FAIR (Facility for Antiproton and Ion Research in Europe)

New accelerator facility

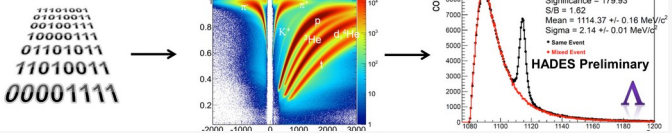
- **Top priority** for European Nuclear Physics Community
- **International**: 50 countries, 3000 researchers
- **Diverse community** from atomic to particle physics

- **'FAIR goes F.A.I.R.': commitment to open science**
- Towards the next generation "data challenge" Volume, Velocity, Veracity, Variety, and Complexity
- **~TB/s data rates,** online processing, ~5x10^5 cores
- Data stored to **disk 40+ PB/year**
- **Distributed computing** with a large user community
- **Data preservation and accessibility key to success**

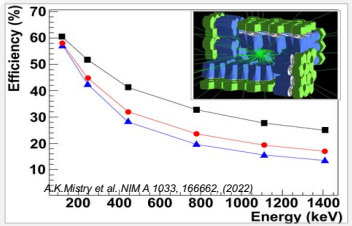


Research Data and Software at GSI: Rich and varied

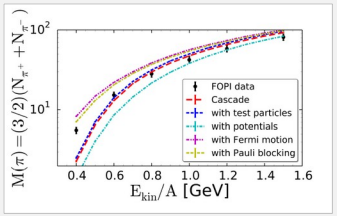
Experimental Data



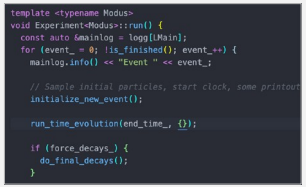
Raw Pre-processed Result



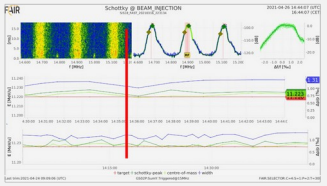
Simulation



Theory



Software



Machine Parameters

Research Area	Exp. Run Time	Raw Data	Calibrated Data	Simulations	Final Datasize
HADES	3 weeks	130TB	300TB	150TB	<1TB
Materials Science	~Minutes	~MB - GB	-	-	10MB
FAIR CBM	2 months	~20PB	-	-	4PB

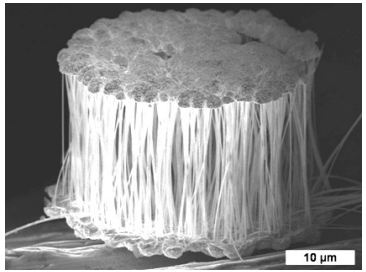
- Data Sizes relatively small but will increase
- Important is the wide range of dataset and metadata types!

Research Data at GSI: Metadata Complexities

Large metadata: materials research

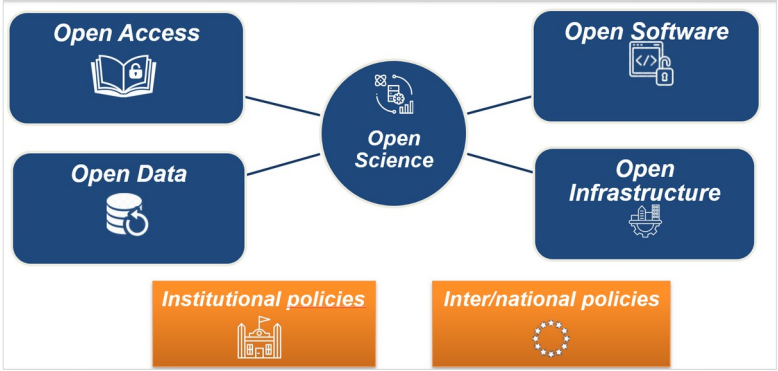
- Raw material
  - Polymer
  - Size
  - Finish
  - Manufacturer
  - Purchase/Fabrication date
- Irradiation
  - Beamline
  - Ion species
  - Charge state
  - Energy
  - Flux
  - Fluence
  - Date
- Pore etching
  - Bath
  - Duration
- Sputter Coating
  - Material
  - Parameters
  - Date
- Back Electrode Deposition
  - Material
  - Electroplating Bath
  - Time
  - Current/Voltage
  - Date
- Wire Deposition
  - Material
  - Electroplating Bath
  - Time
  - Current/Voltage
  - Date
- XRD Analysis
  - Scan Type
  - Angular Range
  - Tube Parameters
  - Recorded Intensity
  - Date
- Dissolution of Template
  - etchant
  - duration
  - drying method
  - Date
- Offline SEM Analysis
  - Scan mode
  - Detector Type
  - Acceleration Voltage
  - Magnification
  - Date
  - Wire length
  - Wire diameter
- Online SEM Analysis
  - Scan mode
  - Acceleration Voltage
  - Magnification
- Online Electrical Analysis
  - Manipulator Type
  - Image of contact
  - Wire length/Diameter
  - I/V-curve
- Irradiation
  - Ion species
  - Charge state
  - Flux
  - Fluence
  - Date

F. Koch Research Data Management at GSI/FAIR (2022)



What is Open Science?

- Science lives on the Open exchange of Knowledge; This open culture of scientific endeavor is captured by the term **"Open Science"**
- In essence: Make research results (+ infrastructure) **openly** available to science, industry, and society for reuse with as **few barriers as possible** in sustainable infrastructures
- Defined by: Openness, Transparency, Sustainability, Transfer, Collaboration and Sharing
- **How** to define and shape Open Science practices, tools and dissemination in a way that **maximises the rewards and benefits**?
- Many challenges are faced:
  - How open do we want to go?
  - What resources do we require?
  - How do we showcase the benefits of Open Science to the communities?



Why is Open Science important?

Accelerates **knowledge transfer** by breaking down access barriers to research outputs. -> *Synergies with AI*

Fosters **collaboration** within and across disciplines, leading to quality improvements and new solutions.

Open Science promotes **transparency**, building **trust** among researchers and the public.

Attracting **future researchers**: Open Science signals inclusivity and appeals to diverse talent.

Sustainability improves as resource sharing reduces repetitiveness

Offers a **new metric** for research assessment to remove the outdated dependence on e.g. h-index

Strengthens **technology transfer** with industry partners

On the agenda of many **governments and funding bodies** (**Helmholtz POF IV+** requires it)

Ultimately, the researcher should benefit from making research outputs open

F.A.I.R. Principles outlines (briefly for info)

https://www.go-fair.org/fair-principles/

Findable

- Centrally orchestrated storage and access of data essential to enable the data/software to be findable.
- Usage of Persistent IDentifiers (PID), Digital Object Identifiers (DOI) -> Guarantee access to Digital Research Objects.
- Generation of ‘data record’ in discipline specific repositories

Accessible

- Data and software produced/dedicated for F.A.I.R communities and publications centrally stored
- Common & “user-friendly” interface to store and retrieve data

Interoperable

- Common metadata formats
- F.A.I.R-produced data operable with other datasets

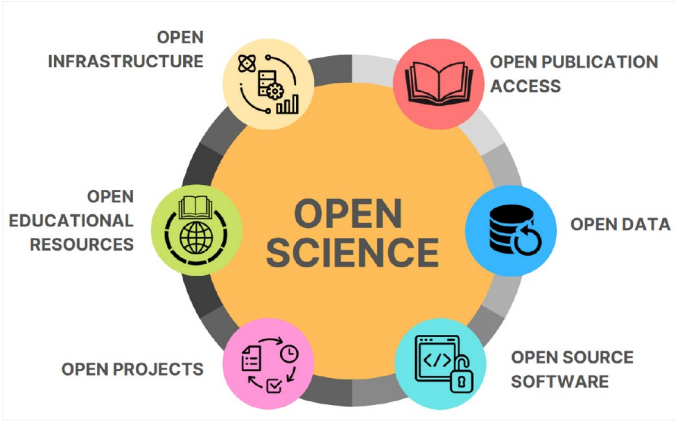
Reusable

- Ensure (as reasonably as possible) data stored long term
- Metadata should be retained indefinitely

Image credit: ARDC licensed under a Creative Commons Attribution 4.0 International License

Open Science @ GSI/FAIR: What do we want to achieve?

- **Open Access Publications** : Mandatory publication of Open Access articles
- **Research Data** : Publish in suitable repositories (F.A.I.R. Data)
- **Open Software** : Make Open whenever possible (F.A.I.R. Software)
- **Open Infrastructure :** Open Projects in research and industry
- Develop an **Open Science Ecosystem** to combine everything



GSI/FAIR Open Science Working Group: Testing and implementing Open Science practices

Considerations:

- The steps and processes to achieve this are complex… Start smaller and work up
- Do not make it too '*general*', needs finer granularity and use-cases
- Aim to address **all researchers who use GSI/FAIR**: Students, Postdocs, PI's, Group leaders…

GSI/FAIR Open Science related Policies/Guidelines

Our foundation stones

Supports researchers & highlights strategy

GSI/FAIR

Coming soon:

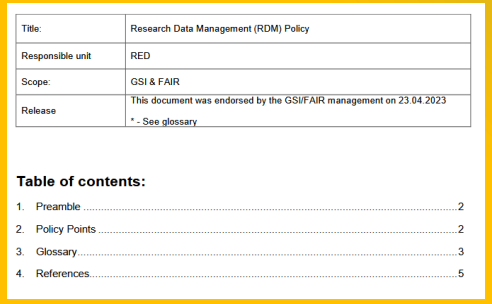
Publication Guidelines

Research Software Guidelines

NuPECC Long-Range Plan: OS Chapter

Research Data Management Policy

(2023)



Title:	Research Data Management (RDM) Policy
Responsible unit	RED
Scope:	GSI & FAIR
Release	This document was endorsed by the GSI/FAIR management on 23.04.2023 * - See glossary

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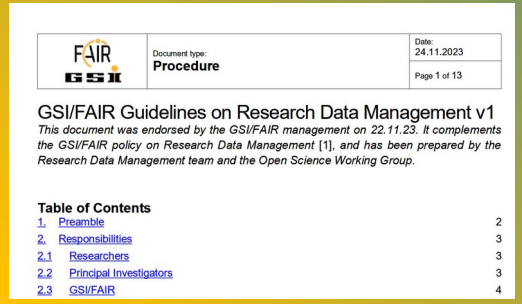
Research Data Management Guidelines

(2023)



Document type: **Procedure**

Date: 24.11.2023

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GSI/FAIR Guidelines on Research Data Management v1

This document was endorsed by the GSI/FAIR management on 22.11.23. It complements the GSI/FAIR policy on Research Data Management [1], and has been prepared by the Research Data Management team and the Open Science Working Group.

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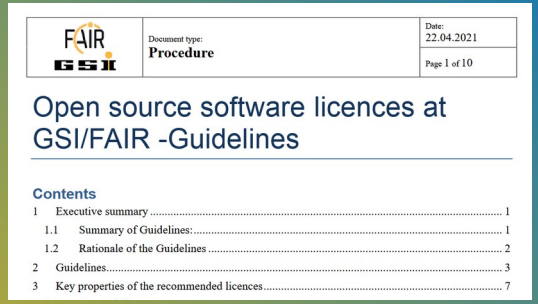
Software licensing guidelines

(2021)



Document type: **Procedure**

Date: 22.04.2021

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Open source software licences at GSI/FAIR -Guidelines

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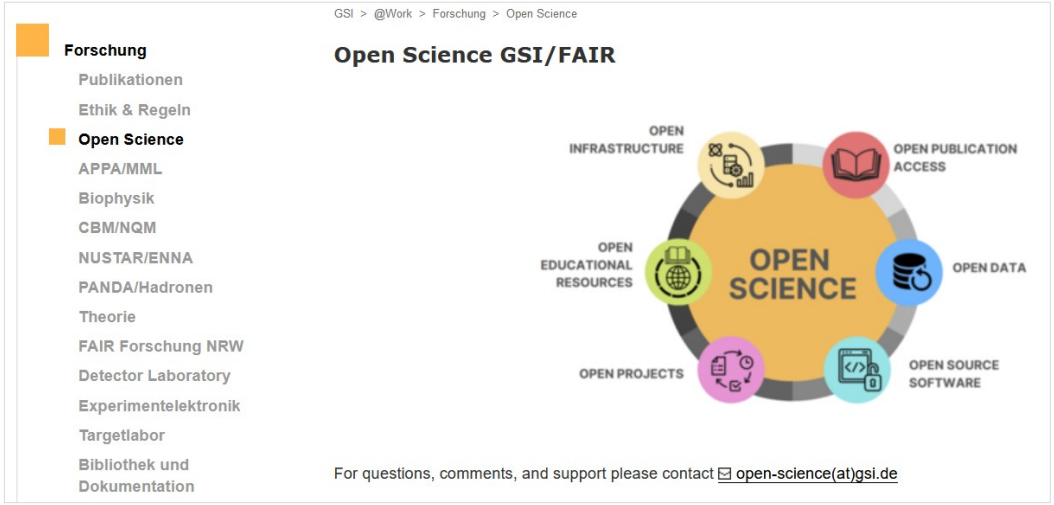
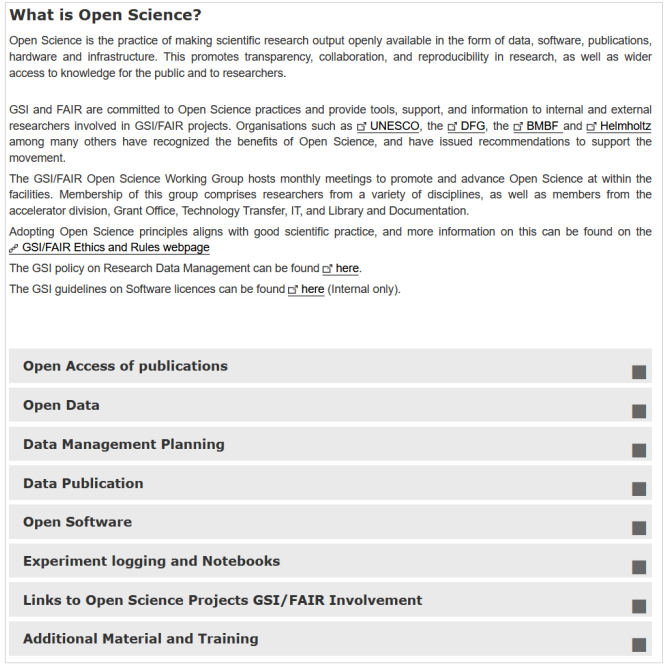
1 Executive summary 1
1.1 Summary of Guidelines: 1
1.2 Rationale of the Guidelines 2
2 Guidelines 3
3 Key properties of the recommended licences 7

Info and Material: GSI/FAIR Open Science Website

Email address: open-science@gsi.de

GSI/FAIR Open Science Webpage: https://www.gsi.de/open-science



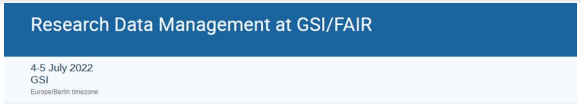


GSI/FAIR Involvement in External OS initiatives

ESCAPE	*European Science Cluster of Astronomy & Particle Physics ESFRI Research Infrastructures:* Open Source Software Repository (OSSR) developer and maintainer
NuPECC	*Nuclear Physics European Collaboration Committee:* Participation and writing Open Science section of the LRP 2024
eosc	*European Open Science Cloud:* GSI/FAIR both observer members, contribution and suggestions for EOSC Future
EURO-LABS	*EuroLabs:* Work Package on Open, diverse and inclusive Science
PUNCH4NFDI	*Particles, Universe, NuClei and Hadrons for the NFDI:* Two Task areas; Developments on data portal, AAI, data lake and other infrastructure from GSI IT department and Research division
MT DMA	*Matter and Technology, Data Management and Analysis:* IT contributions
HELMHOLTZ Open Science	*HGF Open Science:* Members of the OS, software and POF IV indicators working groups
HMC HELMHOLTZ Metadata Collaboration	*Helmholtz Metadata Collaboration:* Participation in HMC funded projects, links and connections to Matter division
EL EM EN TS	*Exploring the Universe from Microscopic to Macroscopic Scales:* Supporting Open Science area of the project (as well as other direct research areas)

Dissemination: RDM/Open Science workshops @ GSI

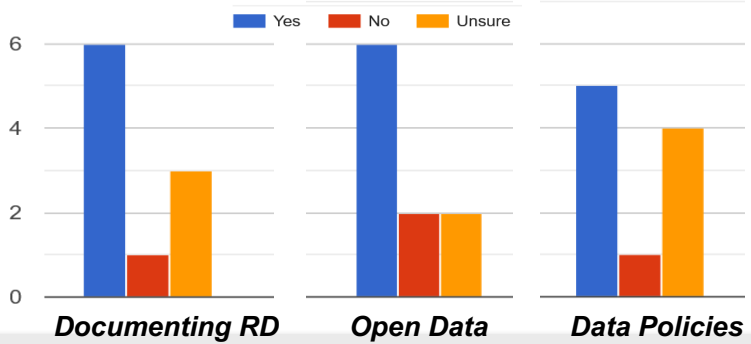
2022 RDM Slides and information: https://indico.gsi.de/event/14680/
2023 Open Science Slides and information: https://indico.gsi.de/event/17498/



⇒ ***100+ participants*** per meeting in two hybrid events,

Variety of themes dicussed:

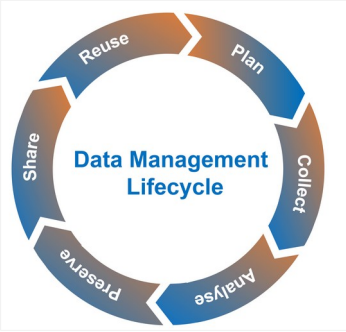
- **Inform and make researchers aware of RDM/Open Science, plans and progress**
- Talks from: **individual research groups, external projects, Tech Transfer, Helmholtz Open Science, Library, Grant office, IT department**
- **RDM questionnaire** distributed after workshop->identify areas to address



Open Research Data and Management

Research Data Management

encompasses all aspects of handling research data, from planning, its generation and processing to publication, long-term archiving, and eventual deletion, while adhering to the principles of good scientific practice.

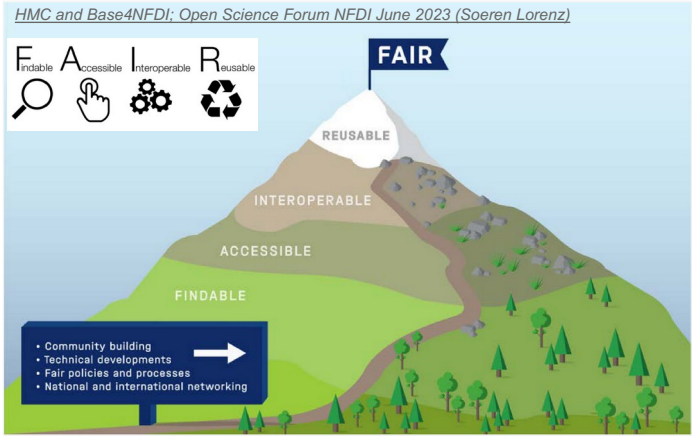


Goals

- to ensure good RDM practices at GSI/FAIR;
- promote and assist researchers in ‘publishing’ data;
- to aim (as best as reasonably possible) that data is published according to the Findable Accessible Interoperable and Reusable principles;
- develop the tools and infrastructure needed to do this (repositories, Electronic logbooks …)

FAIR Data is not an end goal

➢ continual process of improving practices and adapting research resources with technology innovations



Current Tools for Open Science at GSI

Large volume data storage + archiving (Lustre/LTSM/FSQ)

Compute Cluster Virgo

Data Management Planning Software (RDMO): *New*

Electronic Logbooks (ELOG)

Collaboration Tools (Wiki, Indico, Mattermost, Seafile)

Internal publication repository (JOIN2)

Code management system (GitLab)

LxFRS -> new FRS tool!

Tools for Open Science at GSI: *Coming soon* examples

New GSI publications repository: *Testing 2024 -> Go Live 2025*

Metadata schema (NAPMIX): *2024/25/26*

Instrument/Infrastructure PIDs: *Conceptual phase*

Ecosystems/External projects ***PUNCH4NFDI, EuroLabs****: 2023 - 2027*

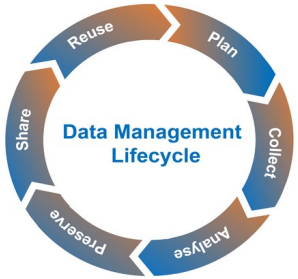
RDM in practice: Data Management Plans

Living document

- Prepared at the start and follows the research data (RD) lifecycle thro

Data management plans

- Communication tool for researchers
- RDM project internal management
- Reuse of RD
- Useful for IT/Resour ates
- Funding b ents



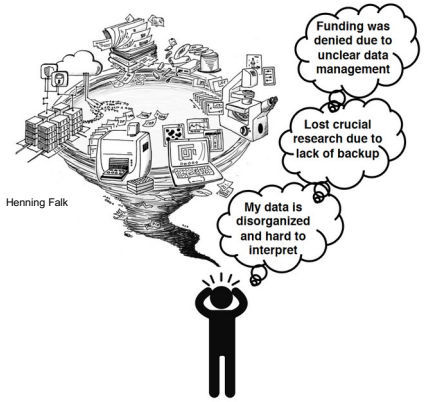
✓Goal : Make it easy for users and encourage preparation

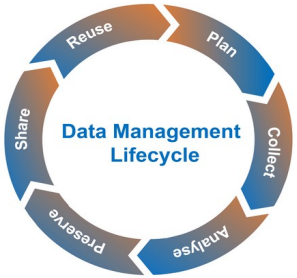
Contents incl

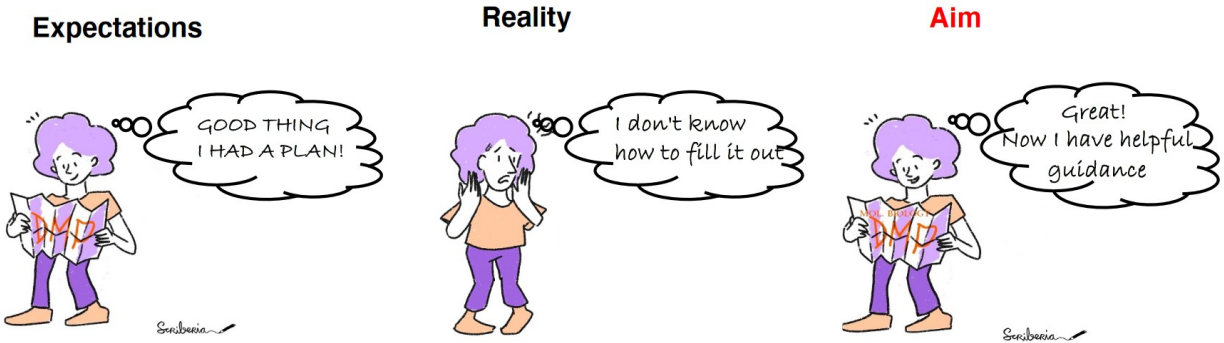
- eral data (Project name/PI, start and end of data taking…)
- RD information (Data type, size, scope, and generation method…)
- Overhead (Data protection, costs, project planning…)
- Achieving and reuse (repository selection, data to be published, metadata schema…)

RDM in practice: Data Management Plans

✓Goal : Make RDM easy for users and encourage preparation



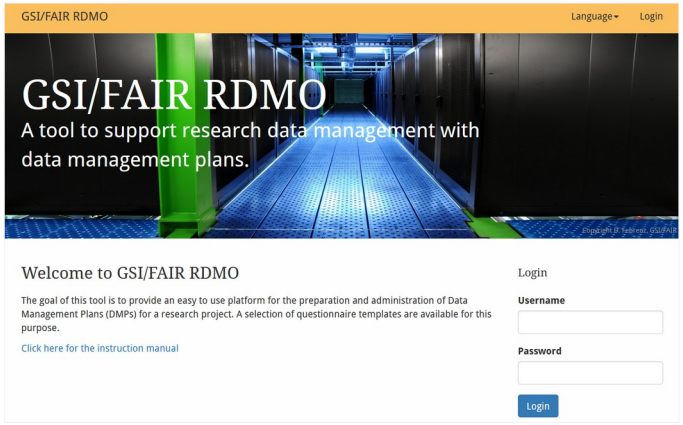




Modified by: Yasmin Demerdash & Sarah Wettermann; *Bridging the Gap: Molecular Biology DMP catalog creation* (2023) https://www.forschungsdaten.uni-mainz.de/files/2023/11/Bridging_the_gap_Demerdash_Wettermann.pdf

RDM in practice: **Data Management Plans**

- Data Management with easy to use tool: **RDMO (Research Data Management Organiser)**
- Currently running production version at GSI/FAIR
- GSI/FAIR tailored catalogue available
- https://www.rdmo.gsi.de
- Highly Recommended to prepare one for your project!
- **For 2024 Experimental Proposal Call:**



Research Data Management Plan (RDMP):

Currently, a RDMP is not obligatory but recommended for accepted experiment proposals.

RDM in practice: Data Publication, things to consider…

- What should I publish? *-> Raw; Pre-processed; Result…*
- What do I need to replicate my result? *-> Software; Workflows…*
- Where should I publish? *-> Zenodo; HEPData…*
- How do I ‘publish’ data? *-> Uploading, linking*
- How much time will it take? *-> 1 day, 3 months…*
- What Licence should I choose? *-> CC-BY?*
- How do I accurately describe my data? *-> Metadata; Written Explanations…*
- How do I ensure that the data is findable? *-> Linking to article/software?...*

RDM in practice: *What should I publish?*

[What do I need to replicate the result(s)?]

Research Data

Raw -> Ideal FAIR data case? Often too large; difficult to process.

Pre-processed -> Feasible option; needs some processing and analysis. Allows further examination of the data

Result -> 'Easiest' case. Can be the data used to make plots etc.

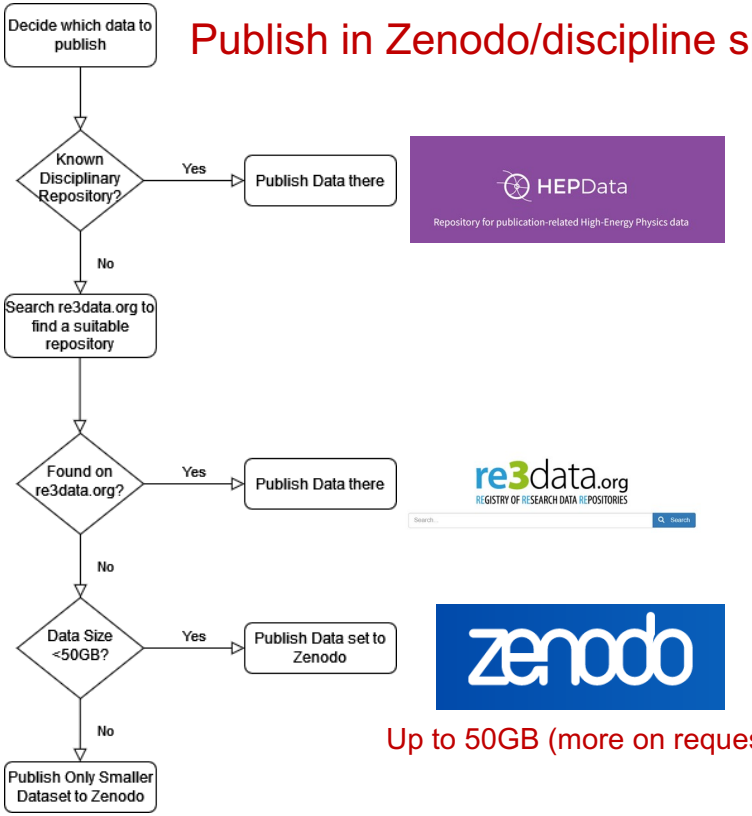
***Others**…. Simulation; Calibration…*

Software -> analysis scripts;

Workflows -> Containers, Descriptions of processing procedures

RDM in practice: *Where/How do I publish?*

Interim strategy



Publish in Zenodo/discipline specific repos

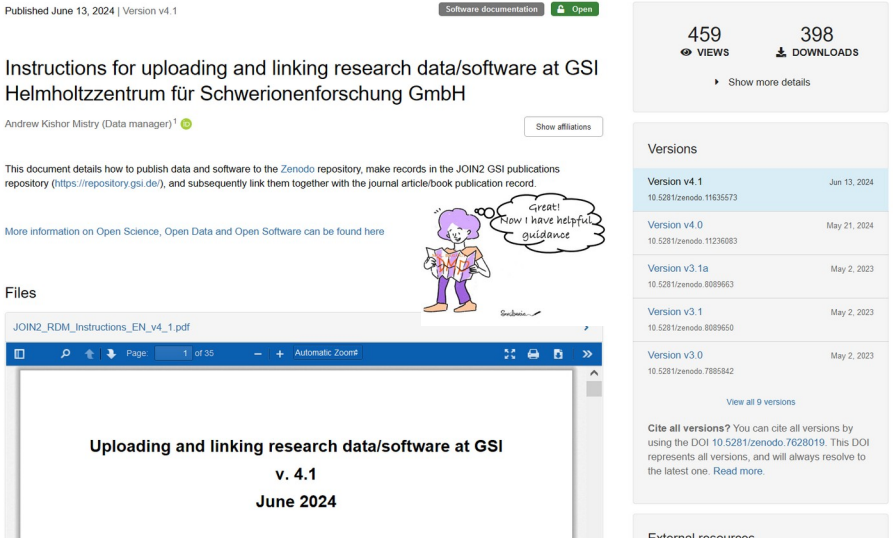
HEPData
Repository for publication-related High-Energy Physics data

re3data.org
REGISTRY OF RESEARCH DATA REPOSITORIES

zenodo

Up to 50GB (more on request)

Instructions available on how to publish data at GSI

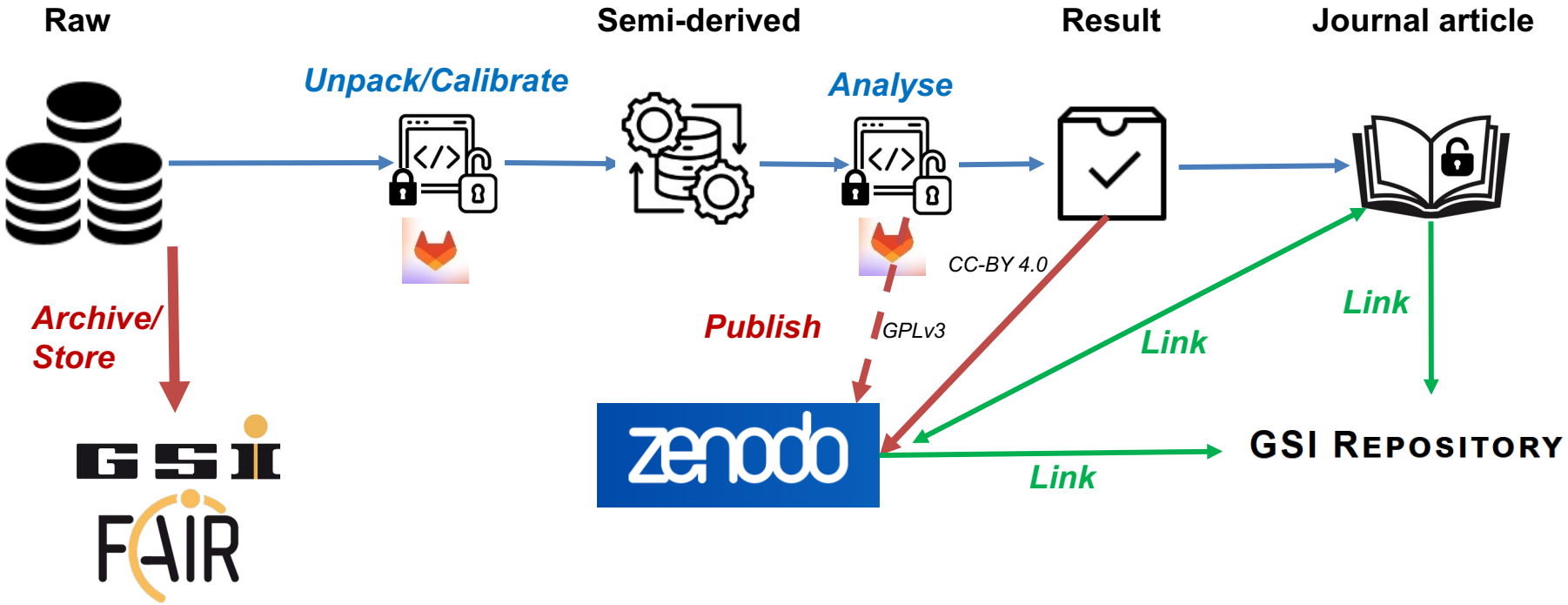


https://doi.org/10.5281/zenodo.7628019

RDM in practice: *Where/How do I publish? [Example]*

[What do I need to replicate the result(s)?]

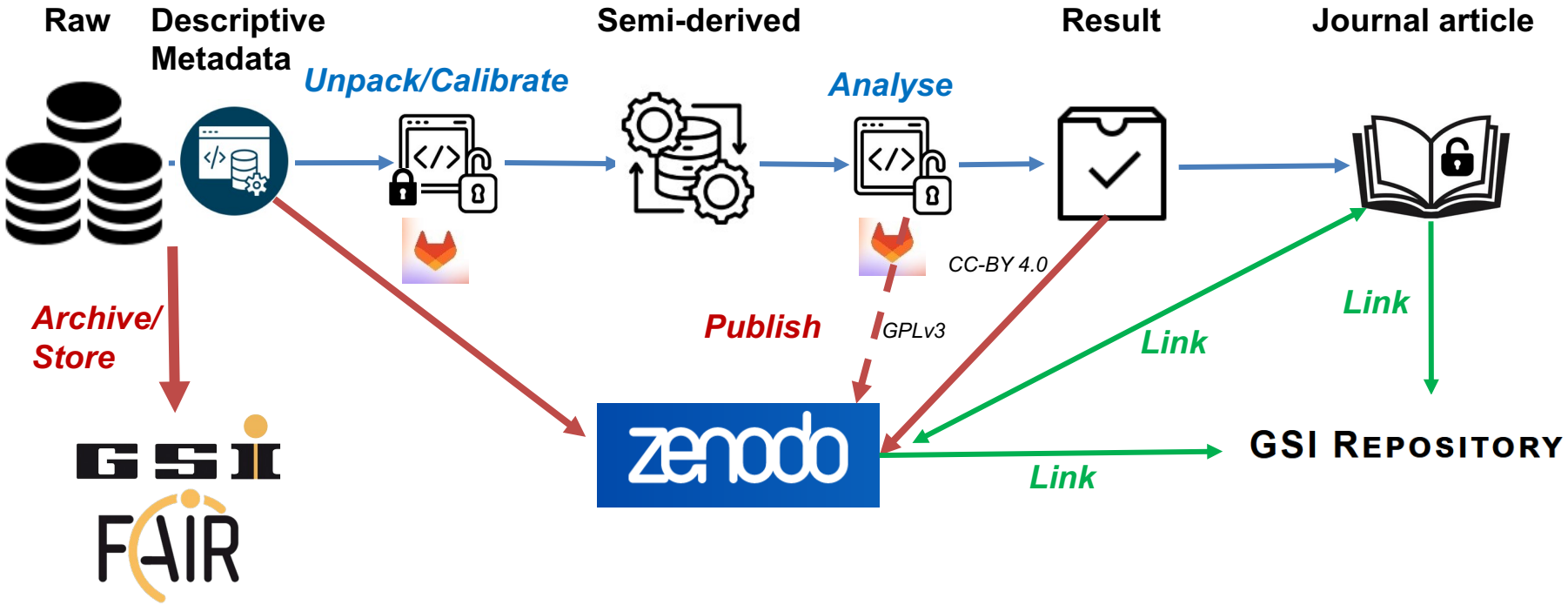
Starting out and keeping it simple: **Result data + analysis scripts**



RDM in practice: *Where/How do I publish? [Example]*

[What do I need to replicate the result(s)?]

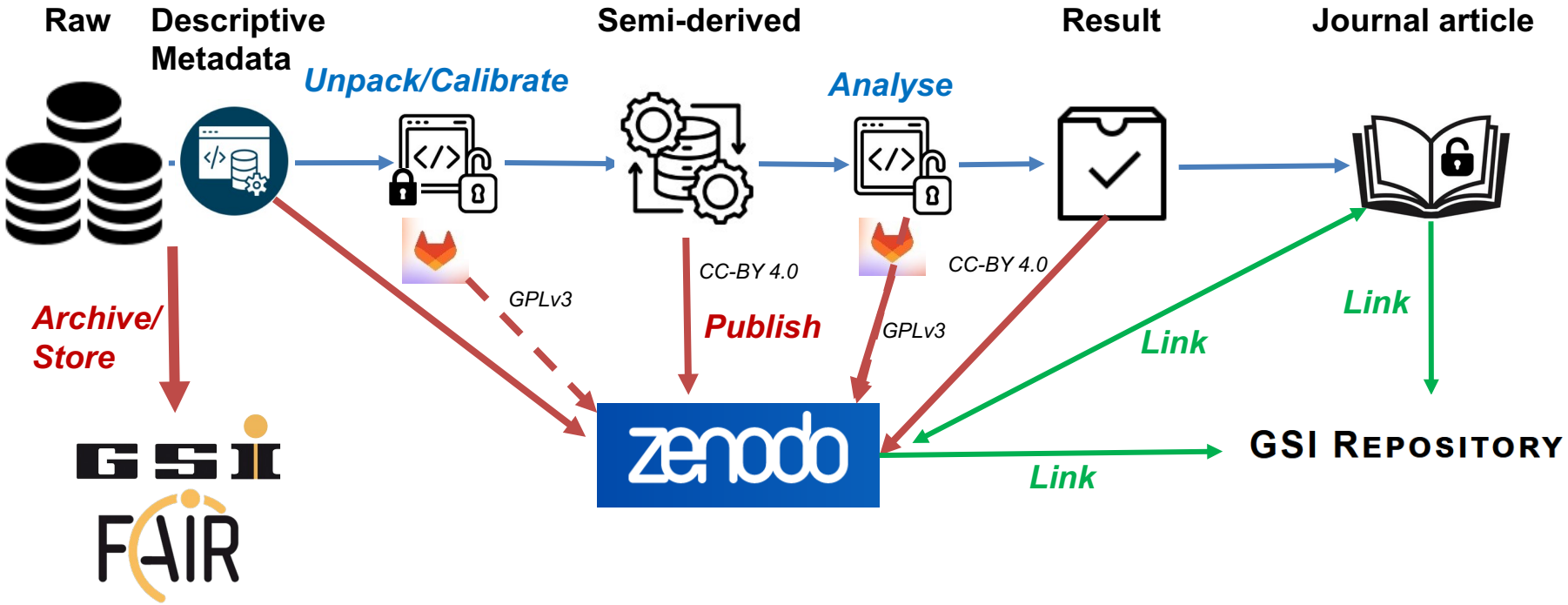
Step forward… Include **metadata**



RDM in practice: *Where/How do I publish? [Example]*

[What do I need to replicate the result(s)?]

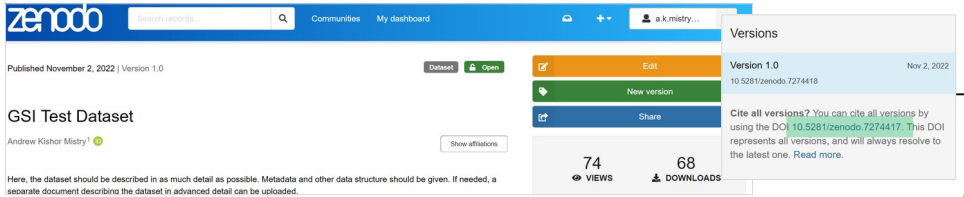
Another step forward: **semi-derived data, software codes, result data** and **accompanying metadata**



RDM in practice: *How do I ensure that the data is findable?*

Article -> Dataset -> Software linking

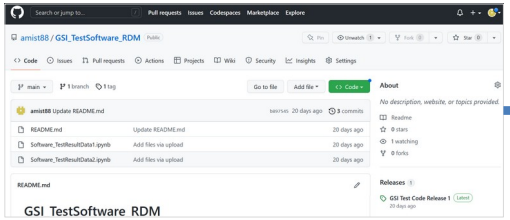
Zenodo: Dataset Record



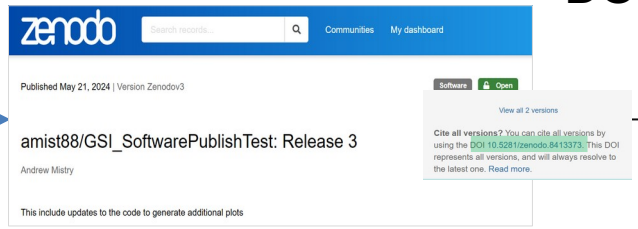
DOI

Publications Repository: Journal Article Record

GitHub/Lab: Software



Zenodo: Software Record



DOI

Datasets/software records in GSI publications repository count towards POF IV

Metadata for nuclear physics experiments

How do I accurately describe my data?

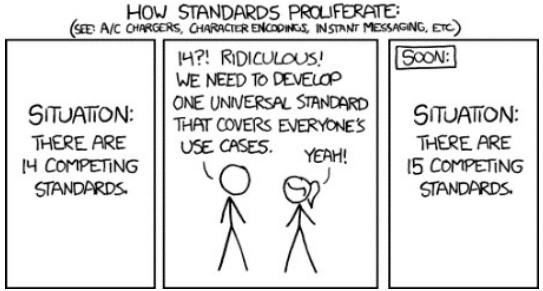
Metadata essential in Research Data Management and Open Science to enable FAIR data (and code)
More info: Guide to HMC Better Metadata Booklet

When publishing data, also publish machine readable metadata

- Allows datasets to be searched for and found
- Enables interoperability between datasets
- Enables reprocessing of data: transparency and integrity
- Efficient use of resources

However: **No common schema yet between nuclear physics experiments - >This is needed**

Caution: Don't reinvent the wheel!
Look for synergies with NeXUS, HELPMI, OpenAIRE et al.



By Randall Munroe: https://xkcd.com/927

Metadata for nuclear physics experiments

Project specific metadata

Project name, publication date, collaborations, researchers, institutions, journal references

Discipline specific metadata

Projectile data, target data, infrastructure, detector type, datasets, software repositories

Experiment specific metadata

Reaction data, gamma-ray energies, time of flight parameters, instrument records

Metadata for nuclear physics experiments:NAPMIX

https://www.oscars-project.eu/projects/napmix-nuclear-astro-and-particle-metadata-integration-experiments

The NAPMIX project emerged to address a significant gap in nuclear physics: the lack of a unified metadata schema necessary for achieving FAIR datasets. This challenge extends to the fields of particle and astro-particle physics, highlighting the need for a collaborative European effort to create a common metadata schema with user-friendly infrastructure. By integrating expertise across these domains, NAPMIX aims to enhance data management practices.

The authors acknowledge the OSCARS project, which has received funding from the European Commission's Horizon Europe Research and Innovation programme under grant agreement No. 101129751

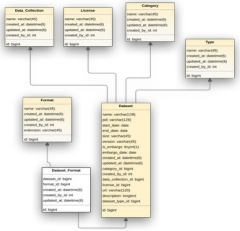
Funded by:

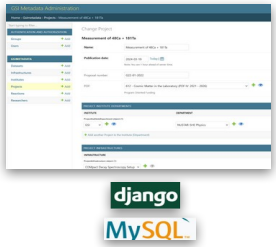
Metadata for nuclear physics experiments: NAPMIX

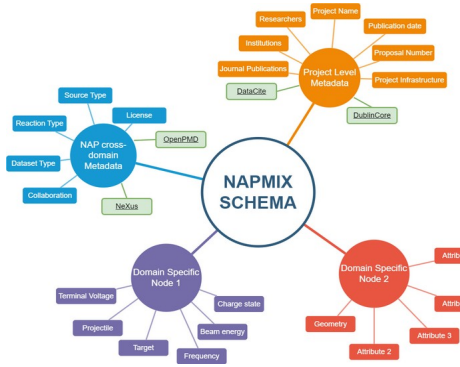
- A front-end generator for user input, producing outputs in both machine and human-readable formats.
- A multi-layered ‘nodal’ structure to incorporate use cases based on real experimental datasets.
- Connections to existing ontologies such as DataCite, OpenPMD and NeXus.
- Interfaces to current infrastructures as a pathway to an Open Science Ecosystem.
- Testing and deployment of the schema with multiple use cases to enhance data FAIRness.
- Training for researchers on the importance and application of metadata.

➢ 24 Months (01/12/24 - 30/11/26)

Concept → Design → Implementation → Schema





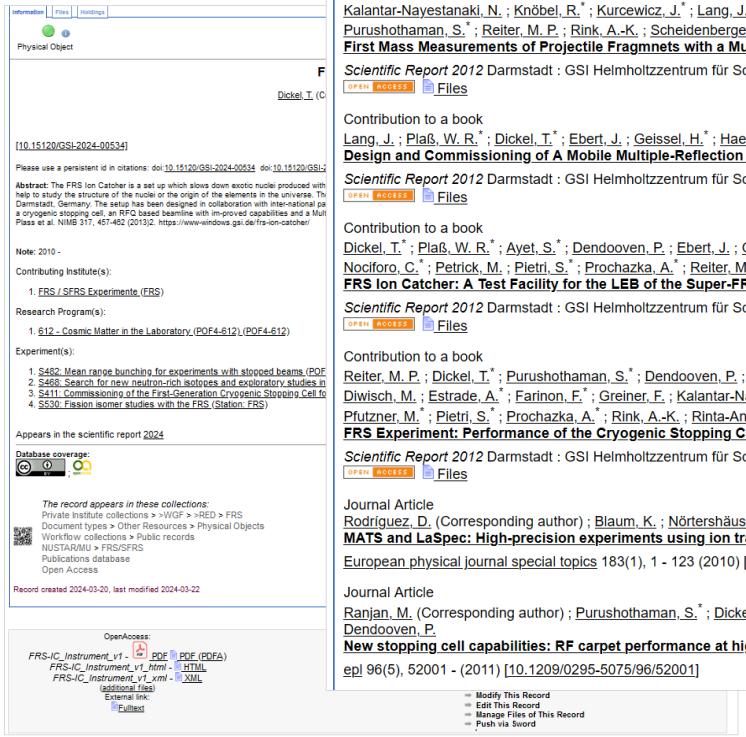


Instrument/Infrastructure Persistent Identifiers (PIDs)

For more information see e.g.:
https://datascience.codata.org/articles/10.5334/dsj-2020-018

- **Goal:** Have a persistent identifier for instruments/infrastructure at GSI
- **Why?**
  - ***Informing users*:** act as a reference point giving insights into technical specifications and capabilities. This also aid ***discoverability*** of the device.
  - ***Providing traceability*:** ensuring that the devices can be traceable and distinguishable for effective monitoring.
  - ***Direct citation*:** not replacing any technical articles on instruments, but acting as a reference point that can be updated as needed.
  - ***Version control*:** keep updates and modifications reported.
  - ***Long-term accessibility and knowledge retention***: ensure the long-term accessibility of information related to the instrument.
- **What is it?** A short (max 2 page) document/web document outlining the technical description of the device including figures. Include versioning and crossovers with other infrastructure
- **How?** Create the record and upload to the GSI publications repository under ‘physical object’. A digital object identifier (DOI) will be assigned.

Instrument/Infrastructure Persistent Identifiers (PIDs)


Physical Object

[10.15120/GSI-2024-00534]

Please use a persistent id in citations: doi:10.15120/GSI-2024-00534 doi:10.15120/GSI-2

Abstract: The FRS Ion Catcher is a set up which slows down exotic nuclei produced with help to study the structure of the nuclei or the origin of the elements in the universe. Th Darmstadt, Germany. The setup has been designed in collaboration with inter-national pa a cryogenic stopping cell, an RFQ based beamline with im-proved capabilities and a Mult Plass et al. NIMB 317, 457-462 (2013)2. https://www-windows.gsi.de/frs-ion-catcher/

Note: 2010 -

Contributing Institute(s):

1. FRS / SFRS Experimente (FRS)

Research Program(s):

1. 612 - Cosmic Matter in the Laboratory (POF4-612) (POF4-612)

Experiment(s):

1. S482: Mean range bunching for experiments with stopped beams (POF
2. S468: Search for new neutron-rich isotopes and exploratory studies in
3. S411: Commissioning of the First-Generation Cryogenic Stopping Cell fo
4. S530: Fission isomer studies with the FRS (Station: FRS)

Appears in the scientific report 2024

Database coverage:

The record appears in these collections:
Private Institute collections > >WGF > >RED > FRS
Document types > Other Resources > Physical Objects
Workflow collections > Public records
NUSTAR/MU > FRS/SFRS
Publications database
Open Access

Record created 2024-03-20, last modified 2024-03-22

OpenAccess:
FRS-IC_Instrument_v1 - PDF | PDF (PDFA)
FRS-IC_Instrument_v1_html - HTML
FRS-IC_Instrument_v1_xml - XML
(additional files)
External link:
Fulltext

→ Modify This Record
→ Edit This Record
→ Manage Files of This Record
→ Push via Sword

Linked articles:

Contribution to a book
Ebert, J. ; Dickel, T.* ; Plaß, W. R.* ; Ayet, S.* ; Dendooven, P. ; Diwisch, M. ; Estrade, A.* ; Farinon, F.* ; Geissel, H.* ; Greiner, F. ; Haettner, E. ; Jesch, C.* ; Kalantar-Nayestanaki, N. ; Knöbel, R.* ; Kurcewicz, J.* ; Lang, J. ; Moore, I. ; Mukha, I.* ; Nociforo, C.* ; Petrick, M. ; Pfutzner, M.* ; Pietri, S.* ; Prochazka, A.* ; Purushothaman, S.* ; Reiter, M. P. ; Rink, A.-K. ; Scheidenberger, C.* ; Takechi, M.* ; Weick, H.* ; Winfield, J.* ; Yavor, M. I.
First Mass Measurements of Projectile Fragmnets with a Multiple-Reflection Time-of-Flight Mass Spectrometer at the FRS Ion Catcher
Scientific Report 2012 Darmstadt : GSI Helmholtzzentrum für Schwerionenforschung, GSI Report 2013-1, 162 p. (2013)
OPEN ACCESS Files
BibTeX | EndNote: XML, Text | RIS

Contribution to a book
Lang, J. ; Plaß, W. R.* ; Dickel, T.* ; Ebert, J. ; Geissel, H.* ; Haettner, E. ; Lippert, W. ; Petrick, M. ; Pikhtelev, A. ; Scheidenberger, C.* ; Yavor, M.
Design and Commissioning of A Mobile Multiple-Reflection Time-of-Flight Mass Spectrometer for In-situ Analytical Mass Spectrometry
Scientific Report 2012 Darmstadt : GSI Helmholtzzentrum für Schwerionenforschung, GSI Report 2013-1, 163 p. (2013)
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FRS Ion Catcher: A Test Facility for the LEB of the Super-FRS
Scientific Report 2012 Darmstadt : GSI Helmholtzzentrum für Schwerionenforschung, GSI Report 2013-1, 206 p. (2013)
OPEN ACCESS Files
BibTeX | EndNote: XML, Text | RIS

Contribution to a book
Reiter, M. P. ; Dickel, T.* ; Purushothaman, S.* ; Dendooven, P. ; Ebert, J. ; Geissel, H.* ; Haettner, E.* ; Jesch, C.* ; Ranjan, M. ; Plaß, W. R.* ; Weick, H.* ; Amjad, F.* ; Ayet, S.* ; Diwisch, M. ; Estrade, A.* ; Farinon, F.* ; Greiner, F. ; Kalantar-Nayestanaki, N. ; Knöbel, R.* ; Kurcewicz, J.* ; Lang, J. ; Moore, I. ; Mukha, I.* ; Nociforo, C.* ; Petrick, M. ; Pfutzner, M.* ; Pietri, S.* ; Prochazka, A.* ; Rink, A.-K. ; Rinta-Antila, S. ; Scheidenberger, C.* ; Takechi, M.* ; Tanka, Y.* ; Winfield, J. S.* ; Yavor, M. I.
FRS Experiment: Performance of the Cryogenic Stopping Cell for the Low-Energy Branch of the Super-FRS
Scientific Report 2012 Darmstadt : GSI Helmholtzzentrum für Schwerionenforschung, GSI Report 2013-1, 210 p. (2013)
OPEN ACCESS Files
BibTeX | EndNote: XML, Text | RIS

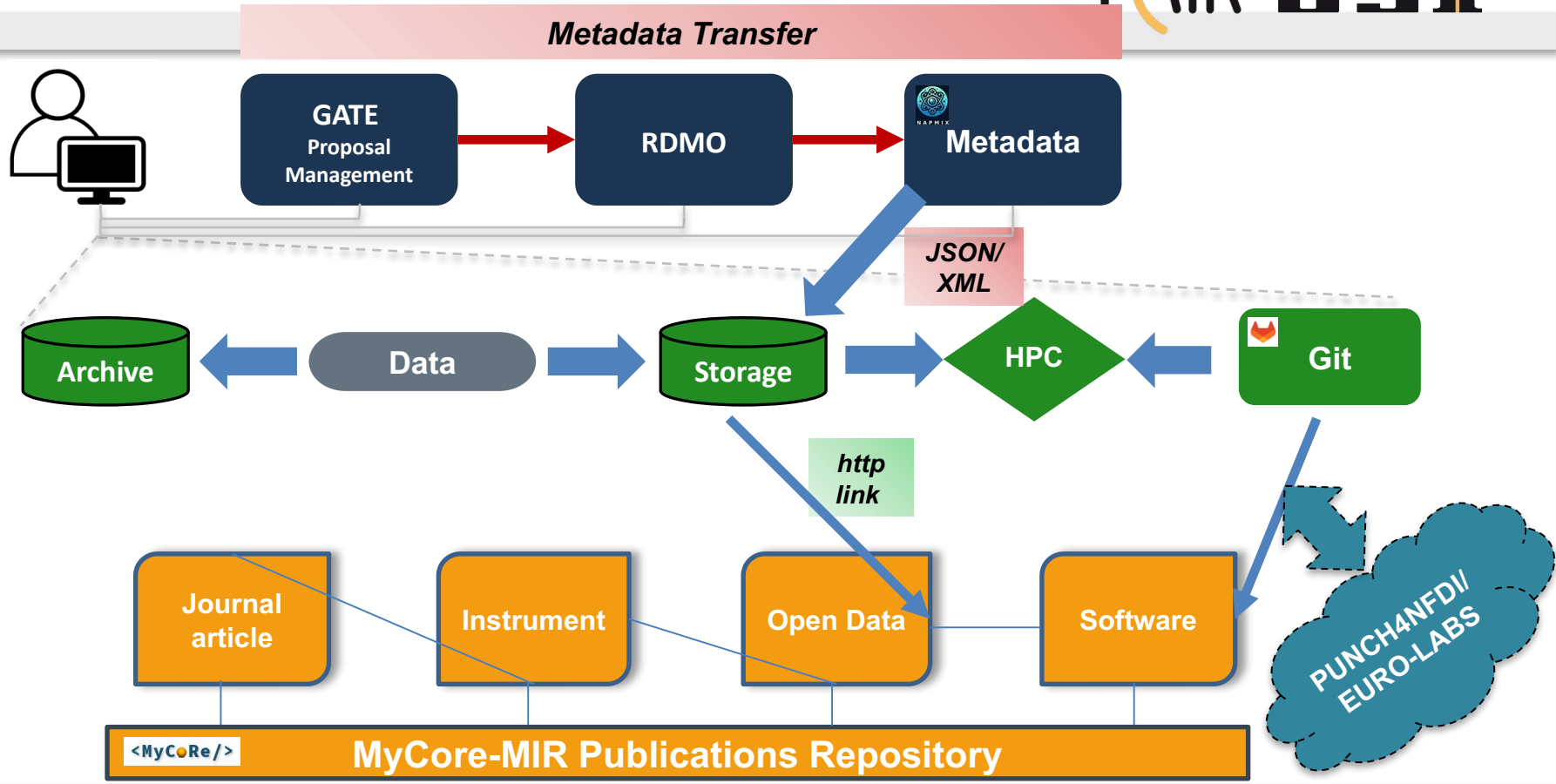
Journal Article
Rodríguez, D. (Corresponding author) ; Blaum, K. ; Nörtershäuser, W. ; *et al*
MATS and LaSpec: High-precision experiments using ion traps and lasers at FAIR
European physical journal special topics 183(1), 1 - 123 (2010) [10.1140/epjst/e2010-01231-2]
BibTeX | EndNote: XML, Text | RIS

Journal Article
Ranjan, M. (Corresponding author) ; Purushothaman, S.* ; Dickel, T.* ; Geissel, H.* ; Plass, W. R.* ; Schäfer, D. ; Scheidenberger, C.* ; Van de Walle, J. ; Weick, H.* ; Dendooven, P.
New stopping cell capabilities: RF carpet performance at high gas density and cryogenic operation
epl 96(5), 52001 - (2011) [10.1209/0295-5075/96/52001]
BibTeX | EndNote: XML, Text | RIS

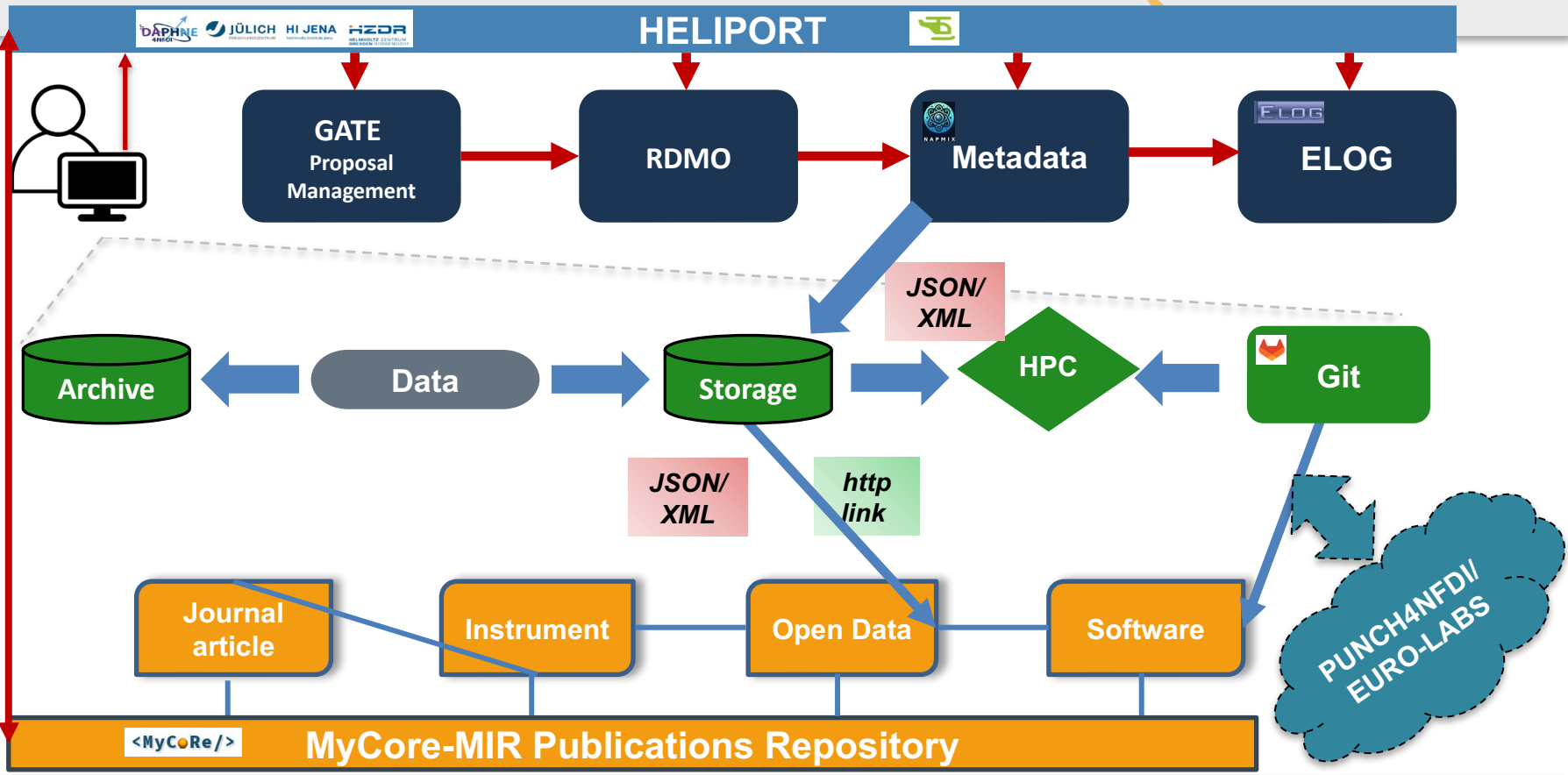
...oder system and downstream detectors before the CSC are missing, they also belong to the setup.

Description:
The FRS Ion Catcher is a set up which slows down exotic nuclei produced with high energies to perform high precision mesurements almost at rest. The properties of the exotic isotopes help to study the s
University Giessen, Germany. The FRS Ion Catcher consist in a cryogenic stopping cell, an RFQ based beamline with improved capabilities and a Multiple-Reflection time-of-flight Mass Spectrometer (MR-TOF-M

An Outlook: GSI OS Ecosystem: Connecting the elements



An Outlook: GSI OS Ecosystem: Connecting the elements

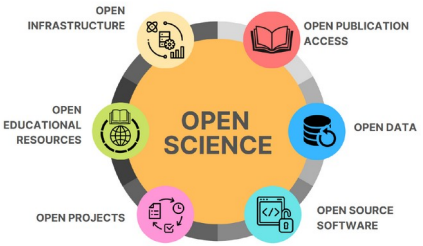


Open Science/RDM @ GSI/FAIR

- **Open Science** cultural change under development at GSI/FAIR, a step-wise iterative approach is underway to best suit the research areas
- We are working to develop **more complex infrastructures** for data/software/workflow F.A.I.R.'ness (with FAIR in mind….): RED/Library/IT department with PUNCH4NFDI, EURO-LABS, ESCAPE etc.

What can/should be done now?

- *Data Management Plans*
- *Open Access Publications*
- *Concepts for Simple Data/Software publication*
- *Engagement with collaborative tools*



We can support: Data Management Plan preparation, Data and Software publication, Metadata development, and other Open Science ideas

Open Science related questions or Comments: open-science@gsi.de
Website Open Science @ GSI/FAIR: https://www.gsi.de/open-science