

Particles, Universe, NuClei and Hadrons for the NFDI

A consortium in the NFDI

PUNCH-2.0 Status and Plans

AG-Tagung Garching, 8 September 2026



Outline

- NFDI and PUNCH4NFDI
- Use cases – examples
- Policy and outlook
- Conclusions



Gemeinsame
Wissenschaftskonferenz
GWK



Deutsche
Forschungsgemeinschaft

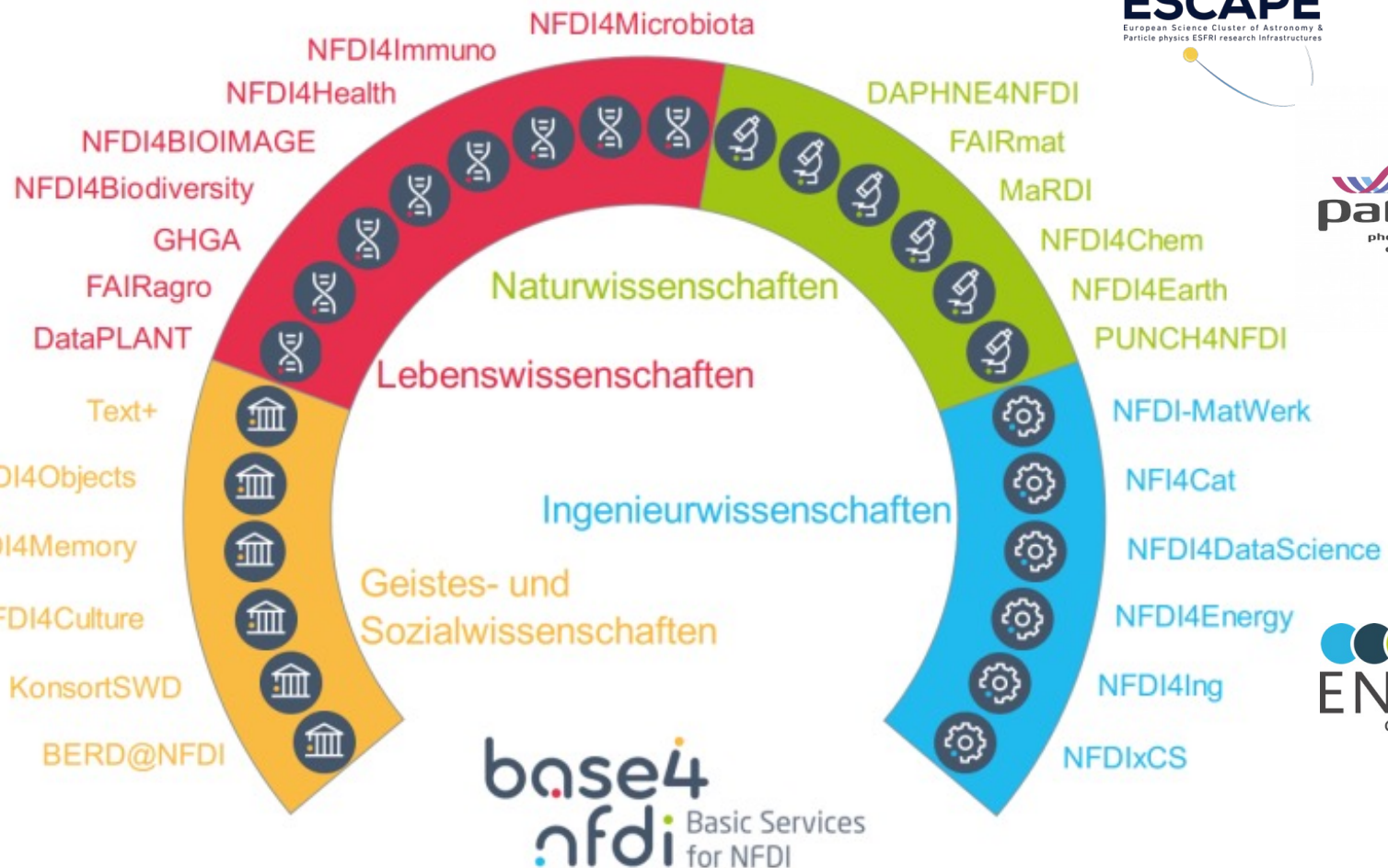
Nationale Forschungsdaten- infrastruktur (NFDI, since 2021)

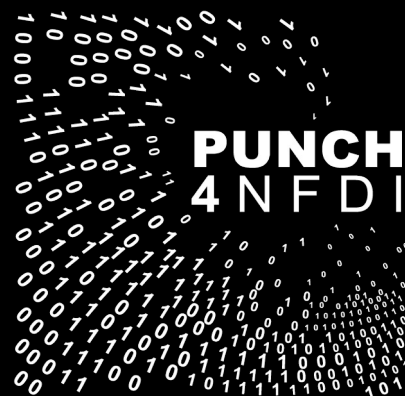
- Sustainable utilisation of scientific research data
- Establishment of FAIR data management and science
- Connection to European and international efforts (like EOSC)
- Bottom-up approach of 26 consortia
- Consortia with up to 5 MEUR / year

See [DFG.de/nfdi](https://www.dfg.de/nfdi) and [nfdi.de](https://www.nfdi.de)

NFDI and beyond

LIFE
SCIENCE RI





Particles, Universe, NuClei and Hadrons for the NFDI (PUNCH-2.0: 34 partners)

Prime goal: setup of federated and "FAIR" science data platform (SDP), offering the infrastructures and interfaces necessary for the access to and use of data and computing resources of the involved communities and beyond.

PUNCH-1 funded 2022-26
PUNCH-2.0 funded 2027-28 (see later)
New "BLV – unclear future

Challenges

- Global flagship experiments
- Many int'l mid-scale experiments
- Globally distributed communities

50 TB all German mobile phones
300 PB FAIR permanent data
4000 PB SKA 1 mid-term archive
10 EB HL-LHC permanent data
30 EB FAIR online / year

2 ZB HL-LHC
online / year

15.6 ZB SKA
before reduction

40 ZB global data
production in 2020

Challenges

- Increasing data volumes – „big data“
- Diversity of experiments, approaches
- Heterogeneous resources
- Data openness and FAIRness
- Real-time data analysis / reduction

The „last dirty (or golden!) mile“: bringing data to the user and making them usable

How to get from our many diverse instruments and the data they produce and typically store in institutional archives



Enhancing European Cooperation in the Search for Dark Matter

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arXiv:2504.01688v2 [hep-ex] 20 Jun 2025

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Abstract

The search for dark matter is an exciting topic that is pursued in different communities over a wide range of masses and using a variety of experimental approaches. The result is a strongly correlated matrix of activities across Europe and beyond, both on the experimental and the theoretical side. We suggest to encourage and foster the collaboration of the involved institutions on technical, scientific and organisational level, in order to realise the synergies that are required to increase the impact of dark matter research and to cope with the increasing experiment sizes. The suggested network — loosely titled “DMInfraNet” — could be realised as a new initiative of the European strategy or be based on existing structures like iDMEu or DRD. The network can also serve as a nucleus for future joint funding proposals.

... more easily to (more) science output?



AAI
Portal
DRPs and registry
RDMO

Retrieval

Preparation

Curation
Selection, combination
MD catalogues
REANA

Analysis

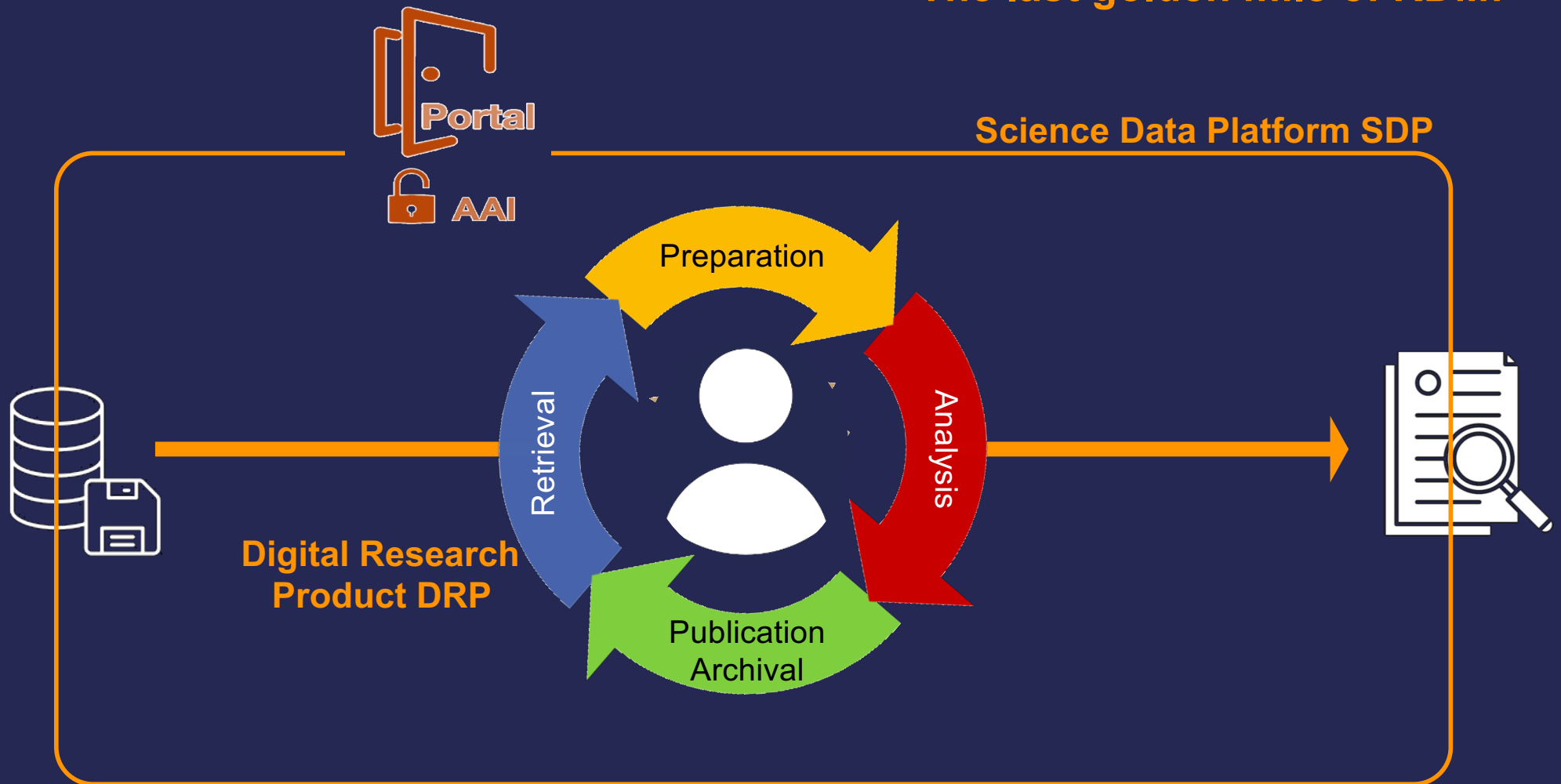
Publication
Archival

Storage4PUNCH
DRPs and registry
MD catalogues
Portal

Compute/Storage4PUNCH
REANA
Statistical / ML / simulation tools
Analysis tools, benchmarks
github & gitlab



The last golden mile of RDM!

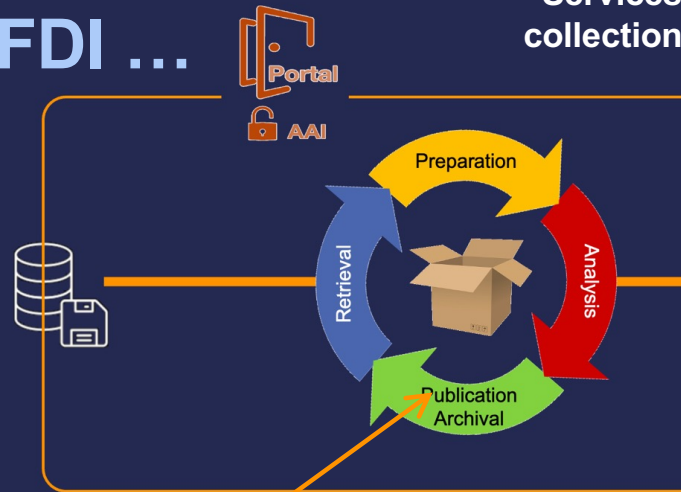


From PUNCH4NFDI ...

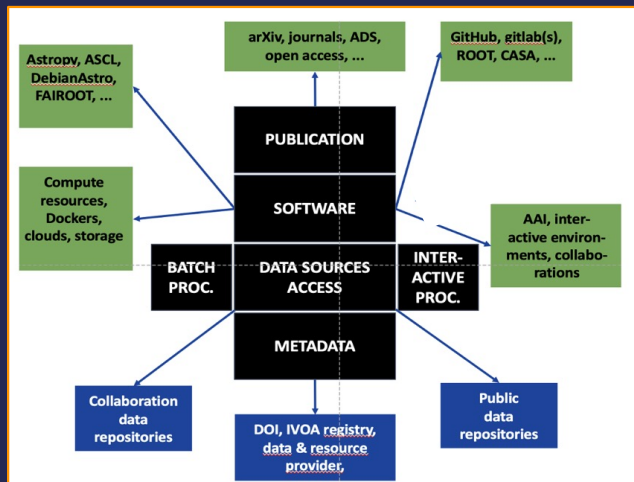
opendata

CERN

ILDG



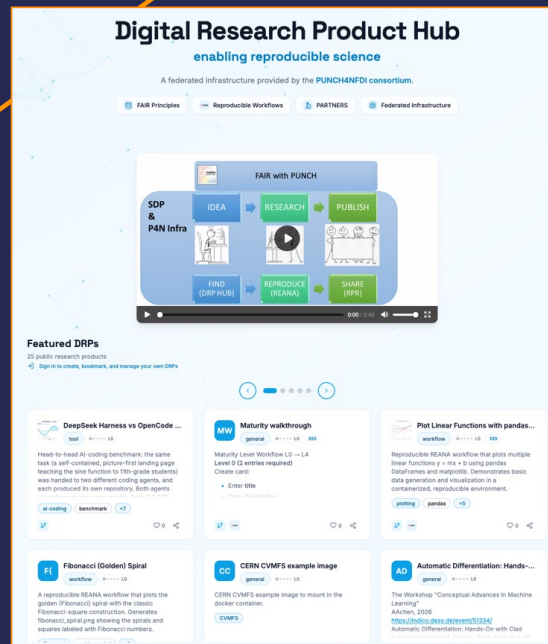
Connection to / use of archives



Digital Research Product

Registry and catalogues

PUNCH4NFDI | AG-Tagung | 8 September 2026 | TS



P4N Gitlab

PUNCH4NFDI's software repository platform. Code Repository, CI/CD, Container Registry, tutorials Gitlab is hosted at AIP.

URL <https://gitlab-p4n.aip.de>

Access AAI

GitLab

Tags git, software, collaboration, Container build (CI/CD), tutorials

P4N AAI

The Community AAI of PUNCH4NFDI, one of the first NFDI AAI, in operation since start of the consortium and managed by us. Provides authentication to user...

URL <https://login.helmholtz.de/punch/>

Register <https://results.punch4nfdi.de/?md=docs/Documents/punch-aa1.md>

Access AAI

Tags DFN-AAI, AARC, HIFIS, EOSC, Single-Sign-On,

P4N DRP Registry

Draft implementation of P4N's DRP (Digital Research Product) registry. Hosted at AIP. See for DRP in <https://zenodo.org/doi/10.5281/zenodo.8358549>

URL <https://rpr-p4n.aip.de>

Access PUNCH-AAI

Tags Workflow, Metadata for Software, Data, Execution

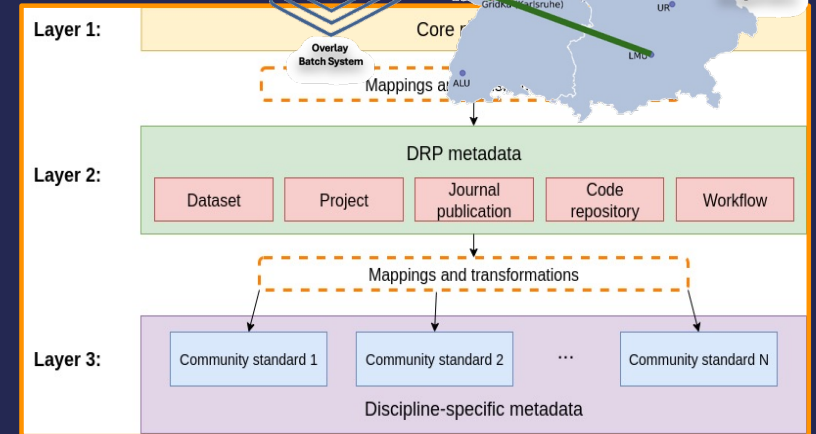
P4N REANA

REANA allows scientists to run containerised data analysis pipelines on remote compute clouds. PUNCH REANA to capture reproducible workflows and...

URL <https://reana-p4n.aip.de>

Federated storage & compute

Metadata schema



From PUNCH4NFDI ... to PUNCH-2.0

154 publications in Zotero data base

>40 co-developed services in data sheet (different levels of authorship)
– from federated infrastructures and AAI to REANA and physics.tools

Contributions to **four** Base4NFDI base services proposals
– preparation of more in the pipeline

Successful achievement of
work programme and deliverables

But also **lessons learned “the hard way”** in first funding phase – concentration and re-focusing in PUNCH-2.0 on
proven technical solutions

user community building

sustainable services

Digital Research Product

Registry and catalogues

PUNCH4NFDI | AG-Tagung | 8 September 2026 | TS

Objective 6: NFDI architecture, sustainability, connections

Objective 5: Education and training

Objective 4: Implementation of use cases

Objective 3: Science Data Platform as user interface

Objective 2: Sustainable services

Objective 1: Technological basis; operation models

TA 3
Service,
Results &
Stakeholder
Management

TA 4
Project Management & Governance

TA 1
Techn.
Foundation

TA 2
Enabling
Science
Exploitation

PUNCH-2.0 TAs, WPs and Use Cases

2.1 Science Data Platform

UC 2.2 Data Management Framework

UC 2.3 Data-Generating Simulations

UC 2.4 Phenomenological Analysis

UC 2.5 Future Observations

UC 2.6 Future Colliders

UC 2.7 Large Datasets

3.1 Services & Results Management

3.2 Training, Education, Open & FAIR

3.3 Stakeholder Management

1.1 Technical Coordination

1.2 Storage Infrastructure

1.3 Compute Infrastructure

1.4 Software, Containers, Registries, DRP

4.1 Overall Project Management

4.2 Financial Management

4.3 Legal Management

4.4 Science Communication

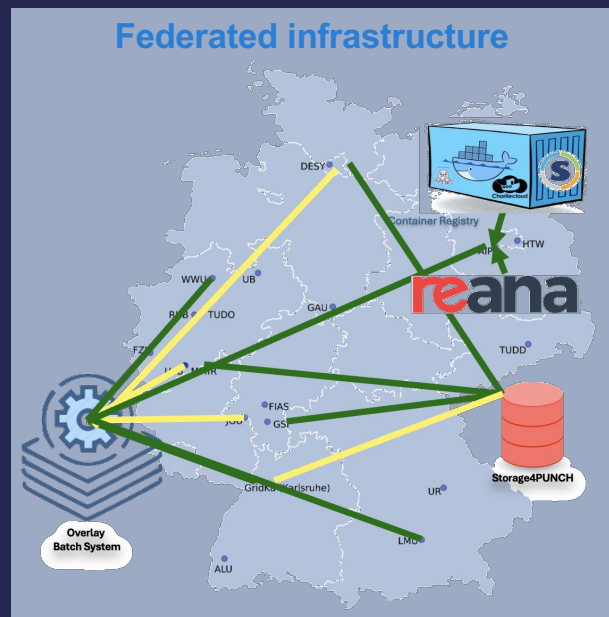
WP 1.2 Storage Infrastructure

S4P: fully integrated storage instances in 4+ locations

PUNCH 1.0: test phase

token-based AAI access
dCache and XRootD

→ **PUNCH 2.0: production phase**
expanding & data hubs
adding **S3** (Cloud Storage Service)
resource monitoring (ICINGA)
+ **DFG storage call**



WP 1.3 Compute Infrastructure

C4P: user-centric, scalable, federated, compute platform

PUNCH 1.0: foundation

Access (EXPLORE service)
Job scheduler (COBaID/TARDIS)

→ **PUNCH 2.0: parallelization**
integrating **HPC** resources
tests, monitoring, recovery
data locality awareness
partnering with **NHR, EESSI**

1.1 Technical Coordination

1.2 Storage Infrastructure

1.3 Compute Infrastructure

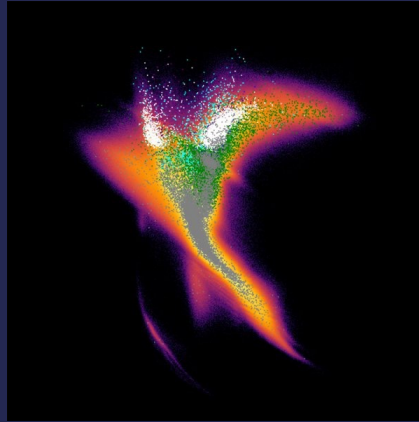
1.4 Software, Containers, Registries, DRP

WP 1.4 Supporting Infrastructure

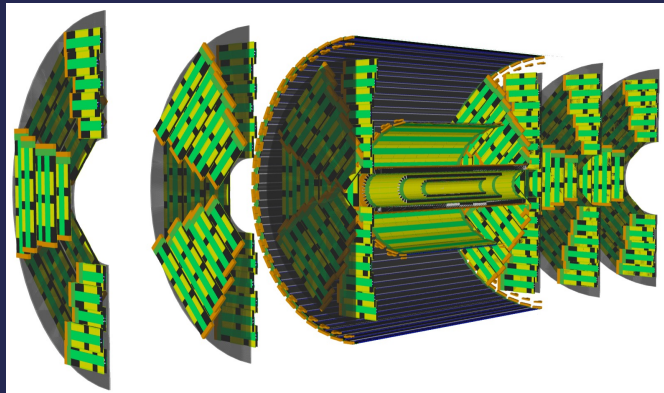
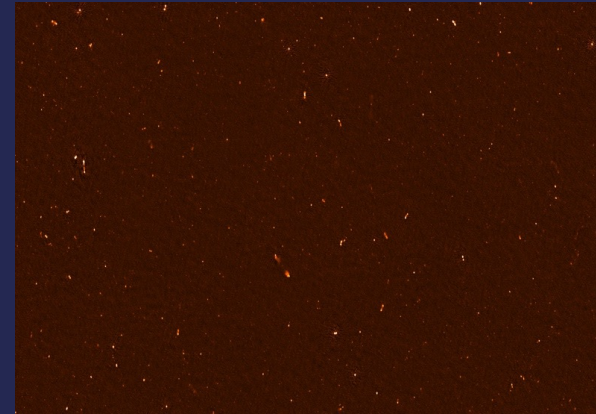
DRP Registry: prototype → **production grade**
Metadata schema: extension and validation
REANA (REusable ANAlysis) platform full integration
Software and container integration into DRPs
User interface (**DRP Hub**, see WP 2.1)

Use Cases Here:

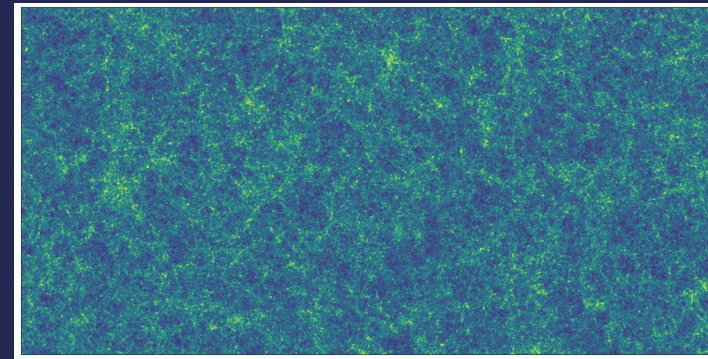
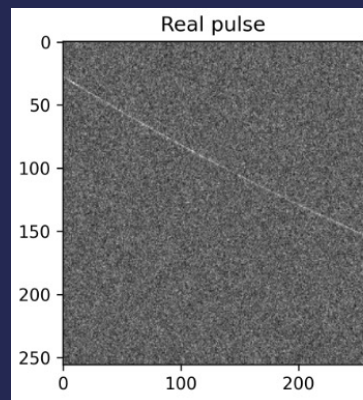
StarHorse BigRun 2025:
Stellar parameters / GAIA data



LOFAR 2m Sky Survey (LoTSS):
Radio interferometry



FCC-ee detector
simulation and physics studies

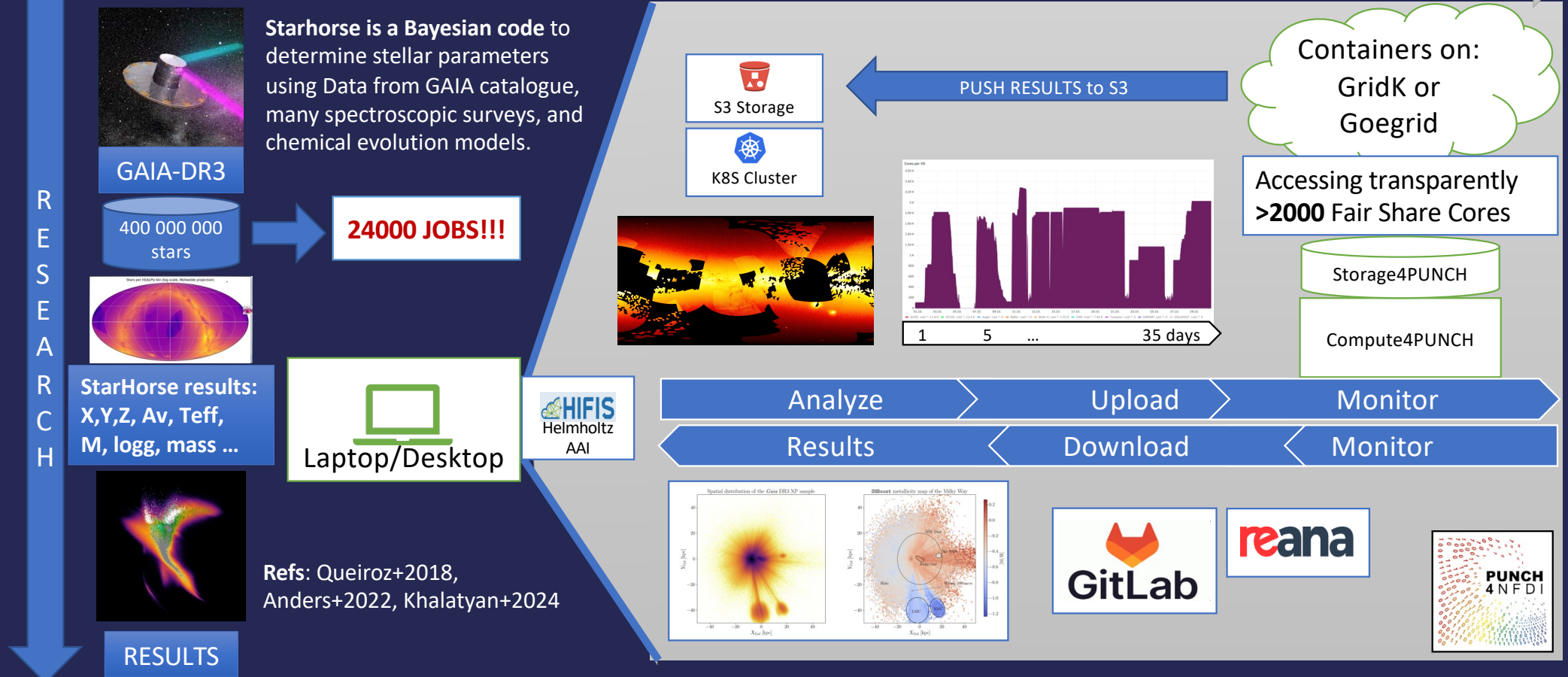


Radio continuum imaging for MeerKLASS

MP-PPA: pulsar analysis with online feedback

End-to-End infrastructure test: "StarHorse BigRun2025"

SUPPORT INFRASTRUCTURE AND COMPUTE RESOURCES



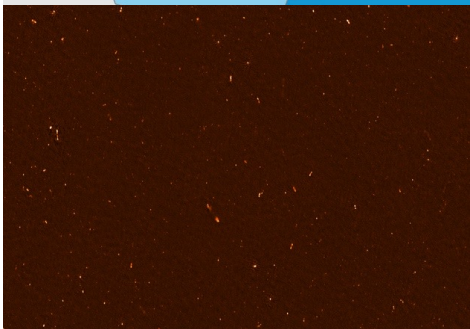
Processing the LOFAR 2m Sky Survey (LoTSS)



- LOFAR data are large (1 TB / hour)
- Features complex interplay of calibration and sky brightness reco (“imaging”) → mixture of HPC and HTC computing
- Ongoing; high science impact expected

Requirements:

- LOFAR data stored in Jülich (1 observation 4-16 TB)
- Current software design requires powerful (single) nodes + scratch (5-20 TB), processing a few 10000 core-h



Dutch stations

Norderstedt

Baldy

Potsdam

Jülich

Tautenburg

Unterwiesbach

Medicina

JÜLICH
Forschungszentrum



LOFAR
long term archive

davix-cp

GRID-certificate + BEARER_TOKEN



condor_submit

KIT compute resources



c4p-login.gridka.de

access token renewal

KIT
Karlsruher Institut für Technologie

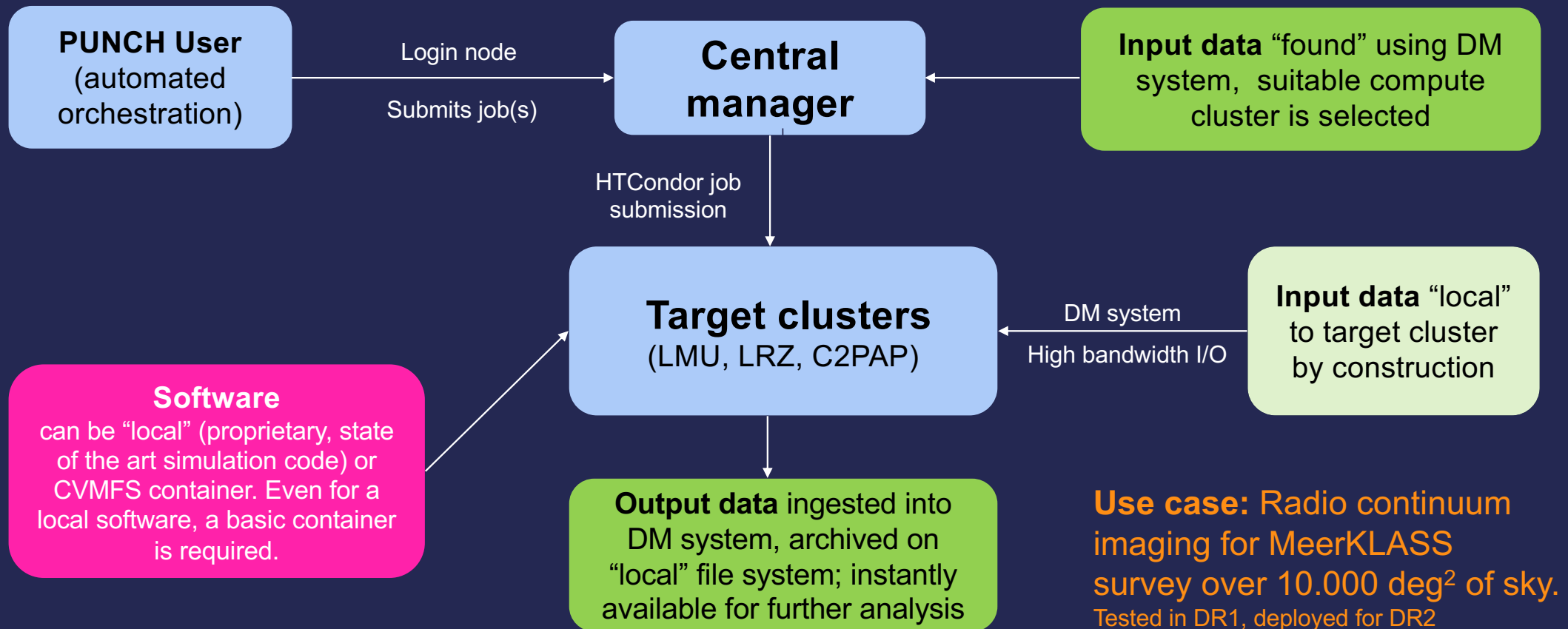
KIT dCache



Storage4PUNCH

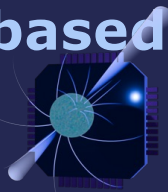
Data transfer challenge

Running jobs on the target cluster using software and data available locally there (*AttachedStorage* for High-Throughput Computing)

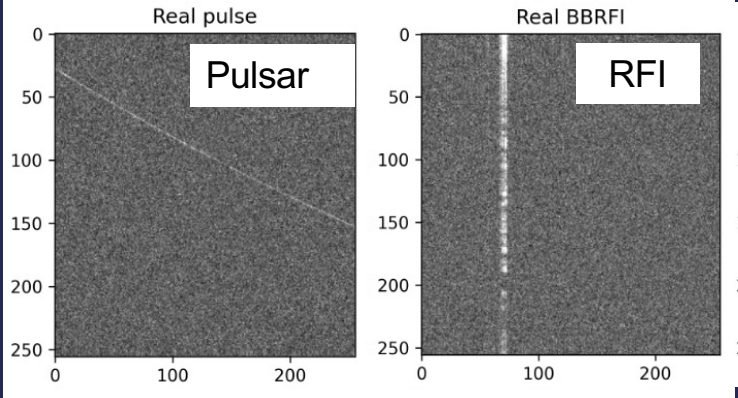
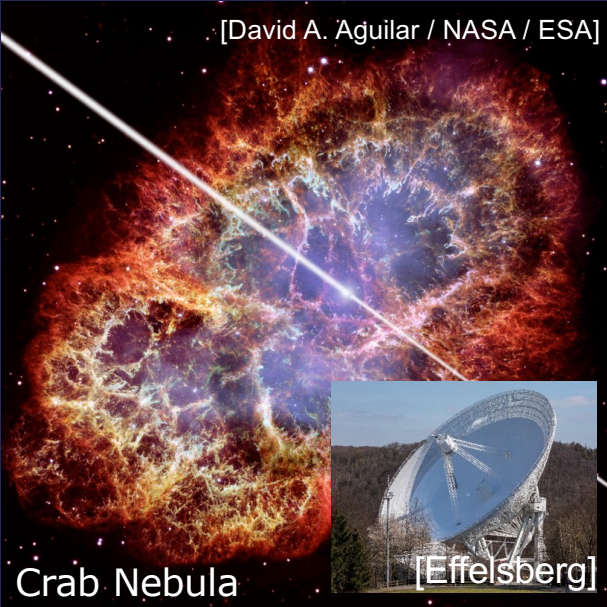
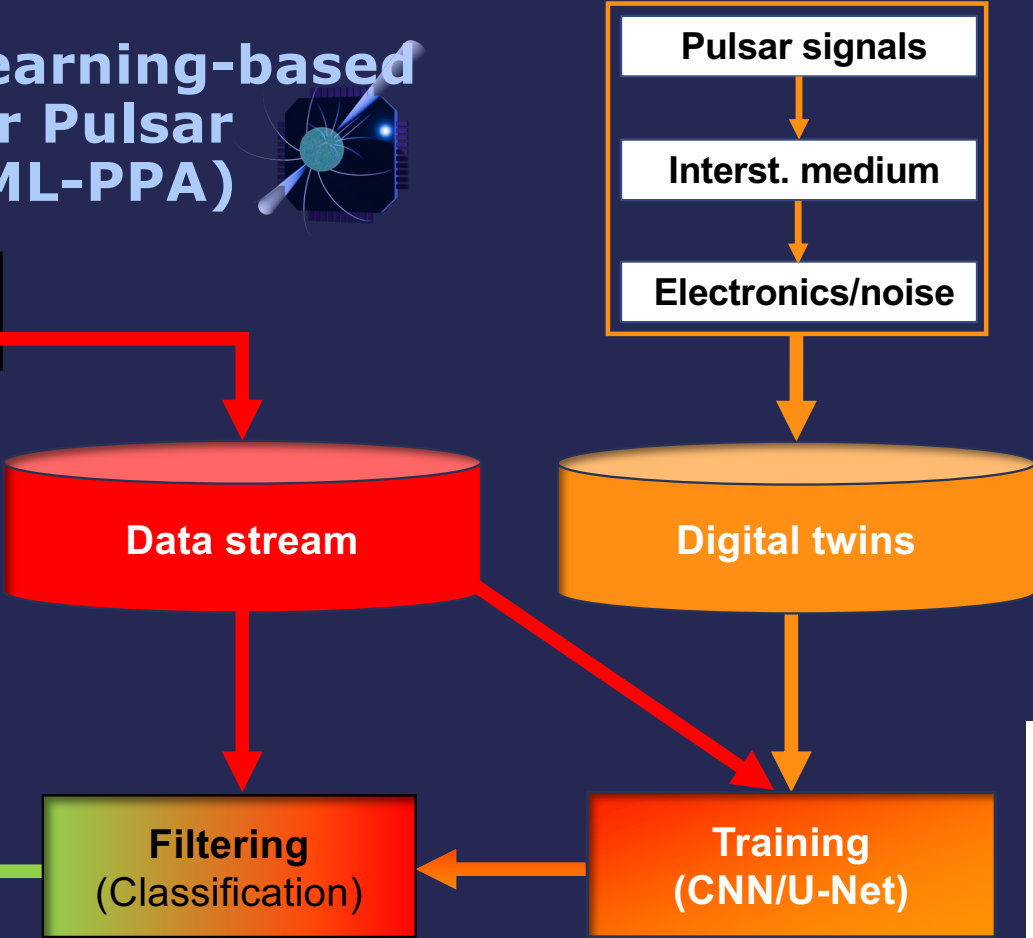


We are integrating RUCIO as data management solution, which will support federated input and output data, each associated with attached HPC

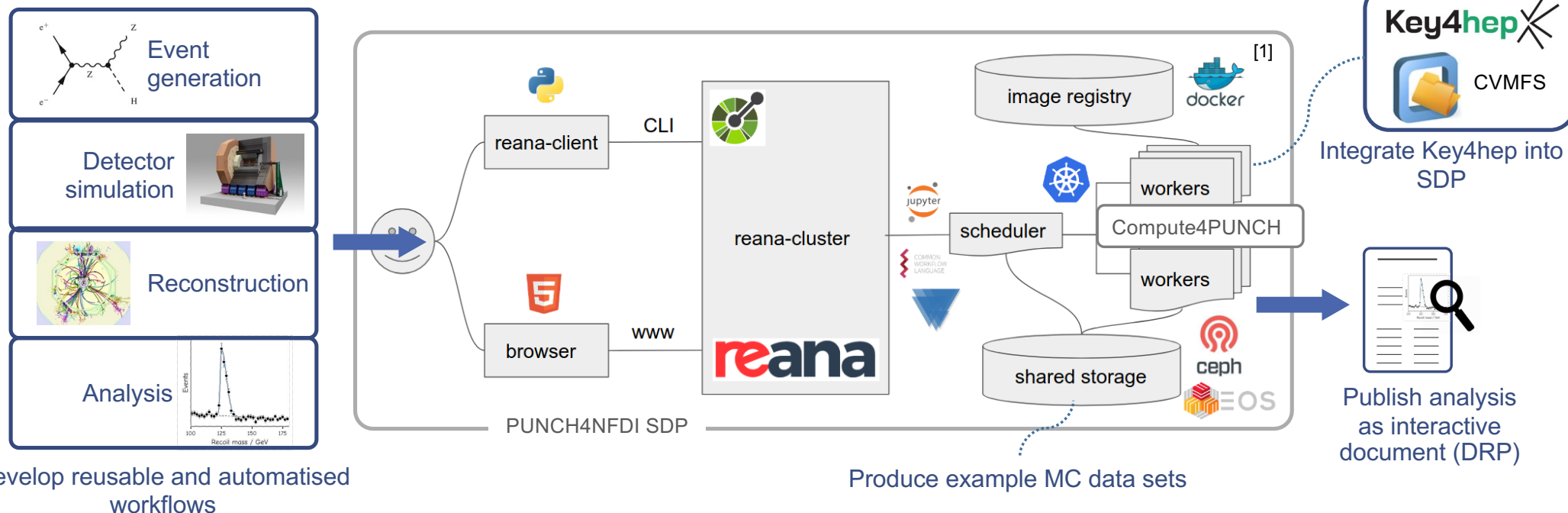
Machine Learning-based Pipeline for Pulsar Analysis (ML-PPA)



Distributed Telescopes



WP 2.6 - Future Collider Applications



- Enables German HEP community to actively shape the design of experiments at the next flagship collider
- Involves complete set of components developed in PUNCH-2.0 for workflow management!

[1] docs.reana.io

A Word on Future Policy

PUNCH-1 funding from Oct 2021 to Sep 2026; new funding guaranteed for Oct 2026 to Dec 2028

Reason for limit Dec 2028: New Federal-States agreement (“Bund-Länder-Vereinbarung”), taking effect 1 Jan 2029 and running at least until 31 Dec 2038

➔ long-term perspective for NFDI, with approx. current annual budget

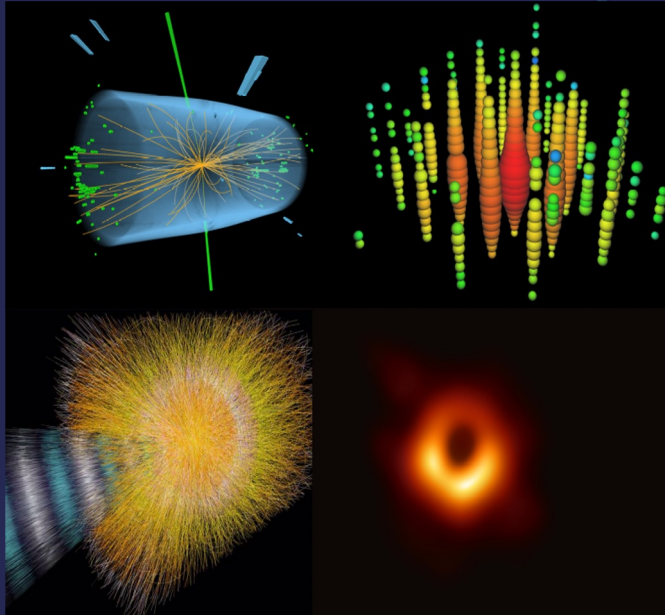
Buts:

- Future role of discipline-specific consortia unclear – less funding certain
- Concept of “Fachbereiche” (e.g. PUNCH+DAPHNE+FAIRMat) and of stronger centralization
- Focus shift from science-driven to service-driven (OneNFDI and integration into EOSC)

Way forward?

- Join forces to get a significant share of NFDI resources? – delicate balance between work for consortium / disciplines and selling points for NFDI support
- Take ErUM-Data also into account.

PUNCH Lines



- FAIR science for PUNCH communities
- Synergies and learning from each other
- Longer-term impacts: DRPs, reproducible science, ...



- 2.1 Science Data Platform
- UC 2.2 Data Management Framework
- UC 2.3 Data-Generating Simulations
- UC 2.4 Phenomenological Analysis
- UC 2.5 Future Observations
- UC 2.6 Future Colliders
- UC 2.7 Large Datasets

- PUNCH Science Data Platform and DRP concept combined with workflow machinery and federated infrastructures
- Use cases for dissemination



- Positioning of PUNCH4NFDI in the complex environment of NFDI, EOSC, international embedding, resource providers, ...
- Building a future (One)NFDI, sustainability,

Thank you!

The PUNCH4NFDI Consortium

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