

Existing Infrastructure 1

Accelerating the Search for Disappearing Light Dark Matter — a Community Workshop

Thomas Schoerner (DESY) and Dirk Zerwas (DMLab)

Bonn
October 02, 2026



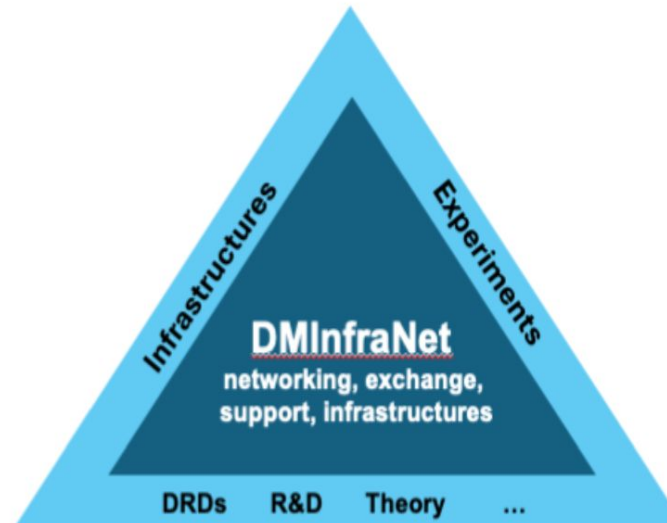
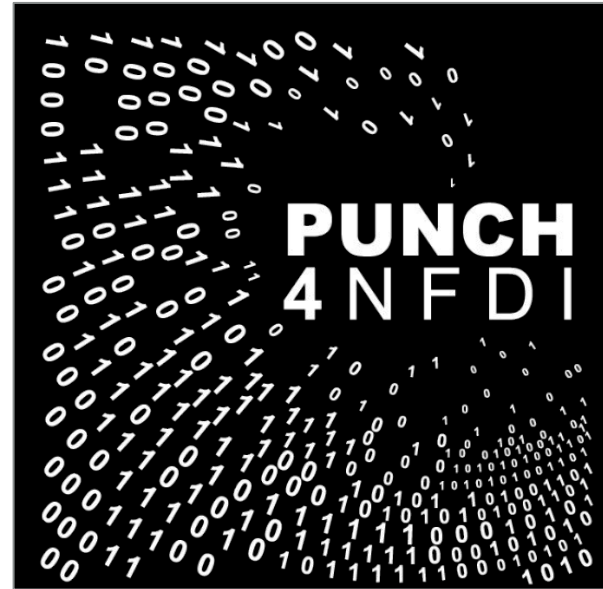
Infrastructure in Various States:

Really Existing Infrastructure:

- PunchNFDI
- Key4hep
- DMLab

Existing Infrastructure hoped for

- DMInfraNet
- DIME



PunchNFDI:

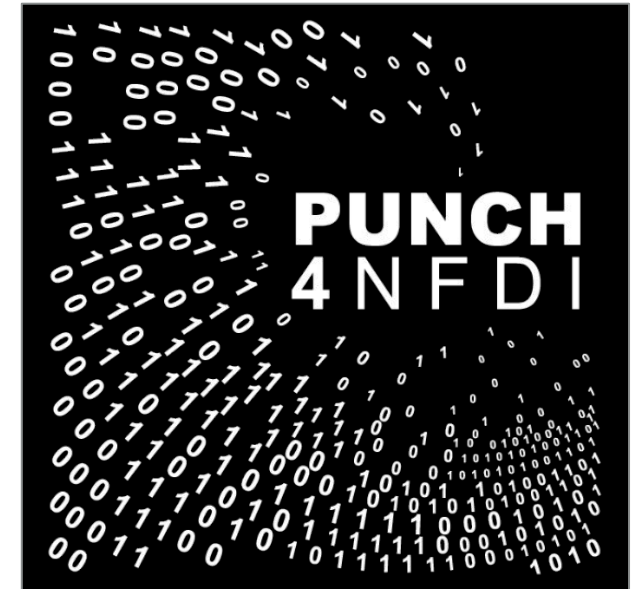
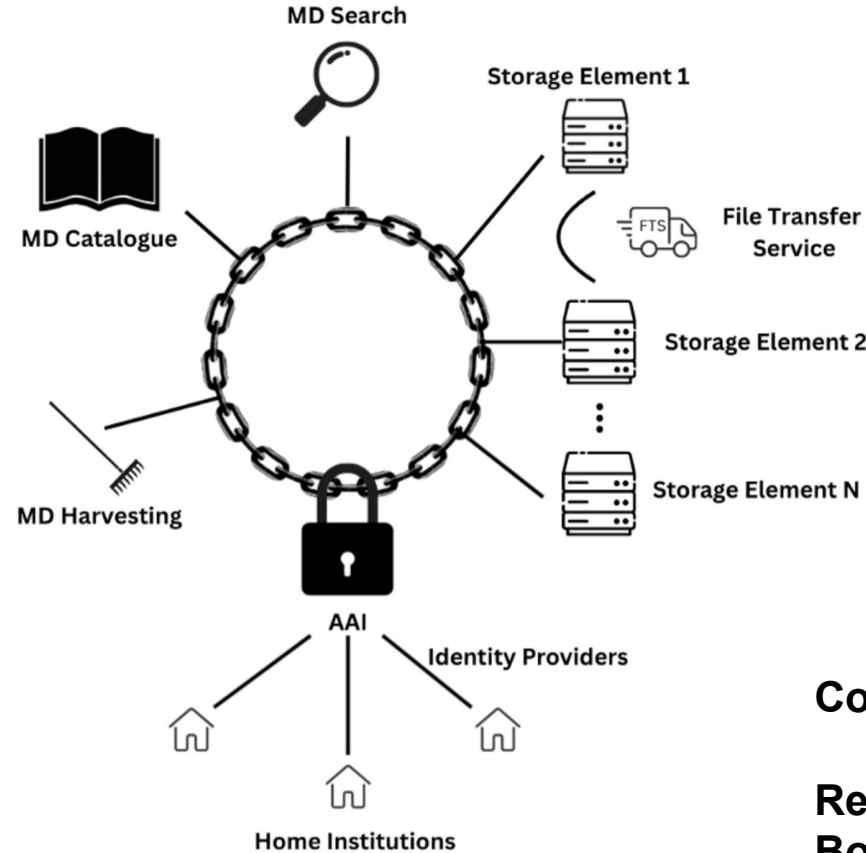
Particles, Universe, NuClei and Hadrons for the NFDI: National Research Data Infrastructure

Sustainable research data utilisation:

- Establishment of FAIR data management solutions
- Connection to intt'nal eg EOSC
- Bottom-up approach of 26 discipline-specific consortia (5 years a 5 MEUR)

Particles, Universe, NuClei & Hadrons 4 NFDI

- ~40 institutions*Max Planck, Helmholtz, universities, Leibniz)
- Focus: “last golden mile of RDM” enabling scientists to more easily extract more science from a FAIRification of existing and new data
- Keywords: Federated compute and storage, AAI, REANA and workflows, digital research products and registry, ...



Connections?

Renewed in 2026!

Bonn and DESY are partners:

Philip Bechtle and Thomas Schoerner (big boss)

Data management model for DIME
PUNCH4NFDI deliverable

Key4hep

see Cedric's talk for Lohengrin

SOFTWARE FRAMEWORK

GENERATORS

SIMULATION

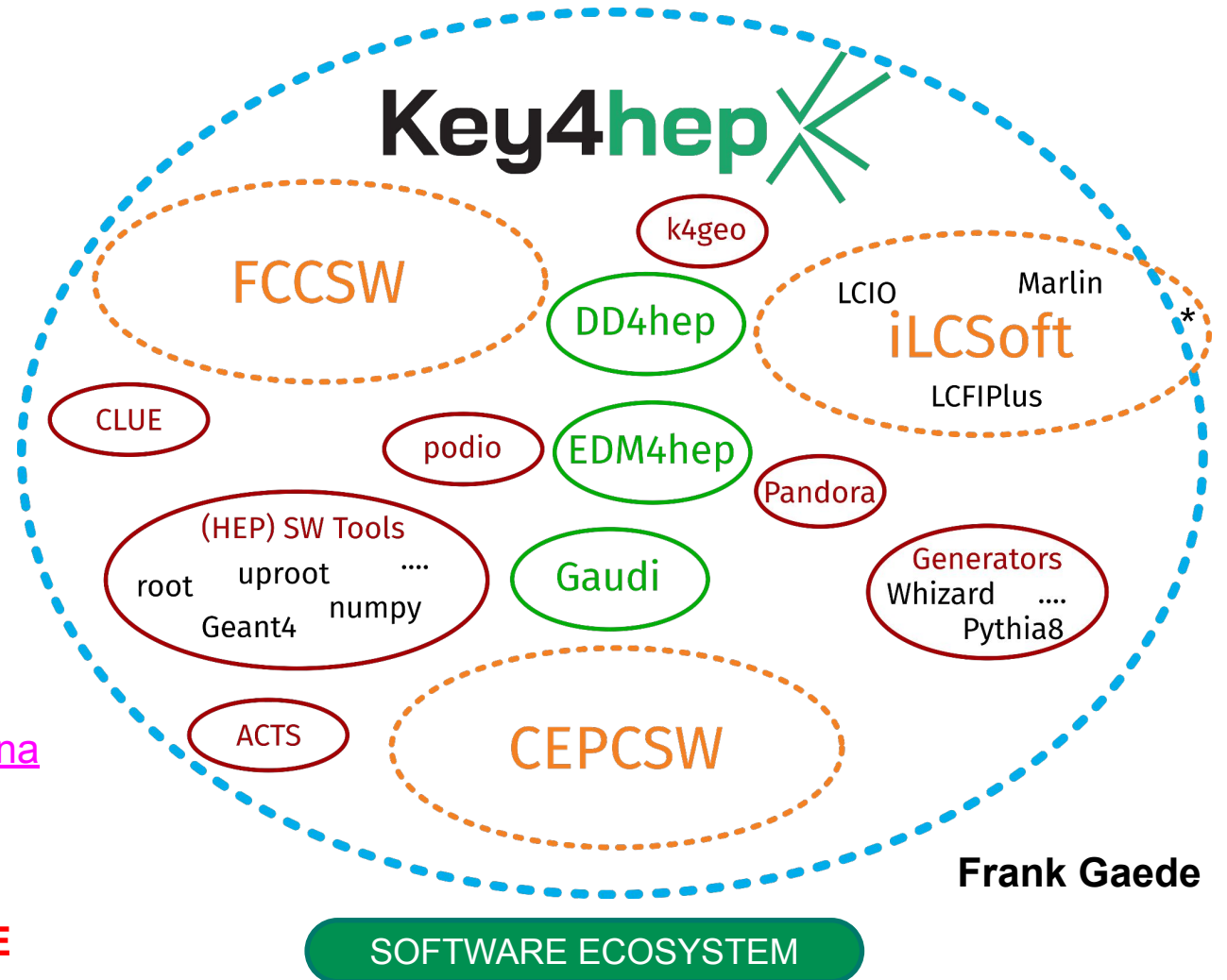
RECONSTRUCTION

Development:

- initiated by ILC, CLIC, FCC und CEPC at the [Bologna workshop](#)
- Eco system
- endorsed by the ECFA workshop pre-ESPPU
- **developed also by EIC, Muon Collider and LUXE**

They have a logo

- Definitely LDMX and Lohengrin inspired



Eco-system:

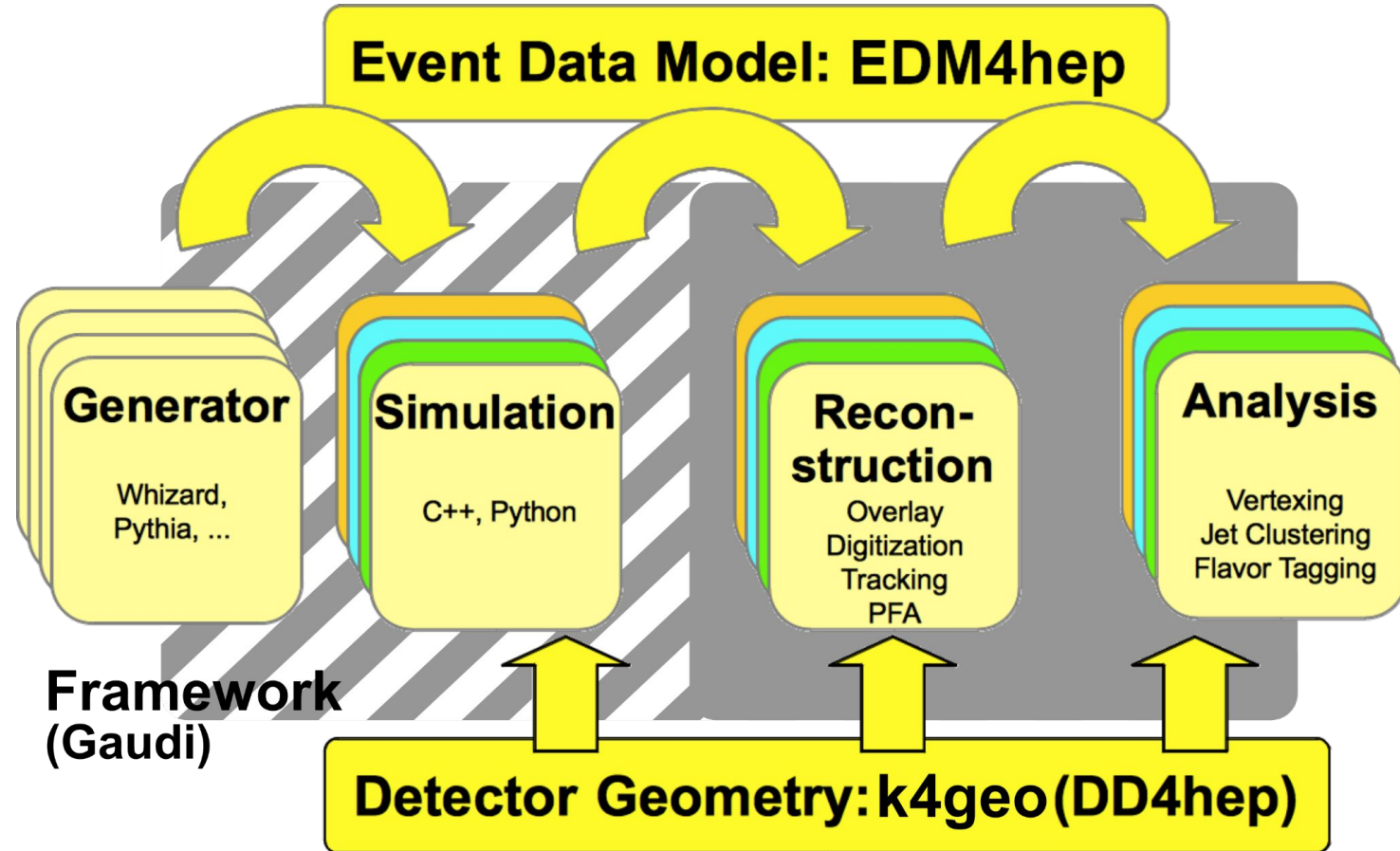
- consistency assured through EDM4hep
- Framework **proposed not imposed** (Gaudi from LHC developments)
- detector geometry consistency between simulation, reconstruction and analysis DD4hep (adopted also by LHCb and CMS)

Central repository:

- centralized storage for detector geometries (k4geo)
- github

Re-usable infrastructure to facilitate SW development:

- CI workflows based on github actions



Extendability:

- yes
- k4GeneratorsConfig (generator comparisons started in ECFA)
-

Support provided:

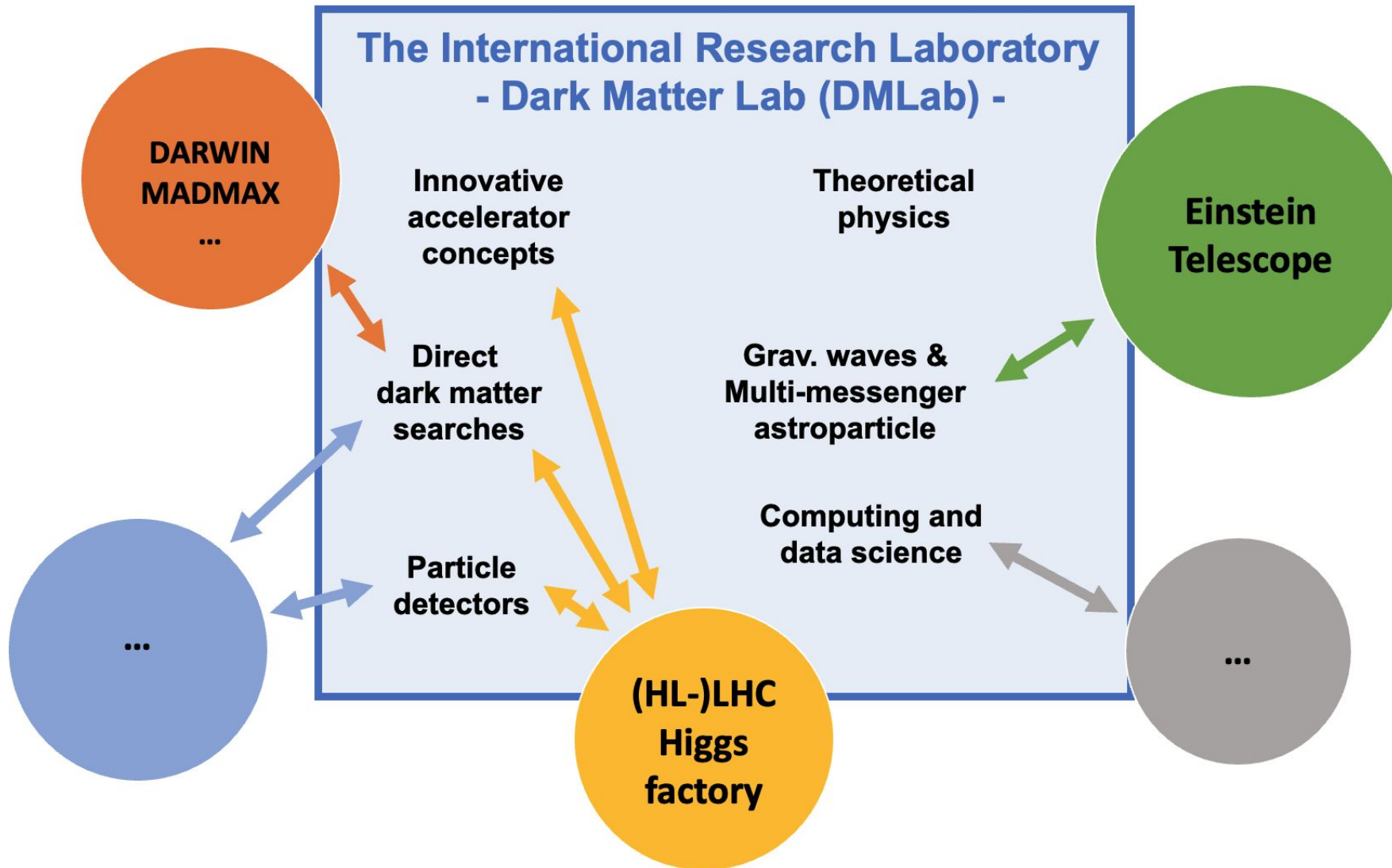
- Central build and releases
- help with integration: Generator, Simulation, Digitization and Reconstruction
- access to newer reconstruction tools (ACTS)

No free lunch:

- definitely willing to interact (dicit Thomas Madlener as coordinator)
- person power limited and mostly dedicated to FCC developments
- interested in developments and feedback by experiments with shorter time scales than FCC:
 - conditions DB
 - Special generators (signal and background) outside the usual suspects (Whizard, Herwig, Pythia, Madgraph, Sherpa, Babayaga,....)

CNRS Helmholtz Dark Matter Lab (DMLab)

Central theme dark matter



IRL tasks:

- develop new ideas
- across topic boundaries
- glued by dark matter

Formally

- **long term visits to DESY, KIT and GSI**
(sabbaticals/expatriation=change of lab, 1y minimum)
- **working visits** (typically 1-2 weeks)
- workshops broad and narrow
- common work
- **try for common funds**

Active since 2024:

- 2 DFG-ANR (**Funding**)
- 1 annual workshop
- 2 special PhDs (**indirect Funding**)
- regular visits (mostly PhD)

Detector Development DRDCalo

SiW Electromagnetic Calorimeter (LLR, IJCLab, Omega, DMLab)

Origin:

- Highly Granular Electromagnetic Calorimeter for **ILD (key4hep)**
- Sampling Calorimeter Si-W, $500\mu\text{m}$
- 9cm x 9cm sensors, lateral cell granularity 5.5mm x 5.5mm

Hardware

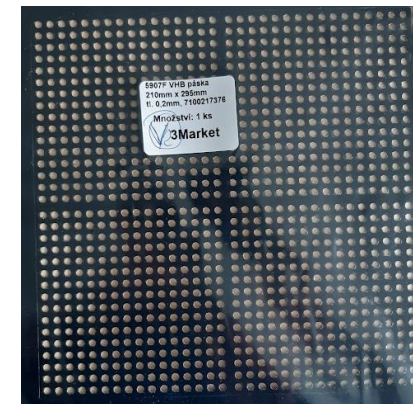
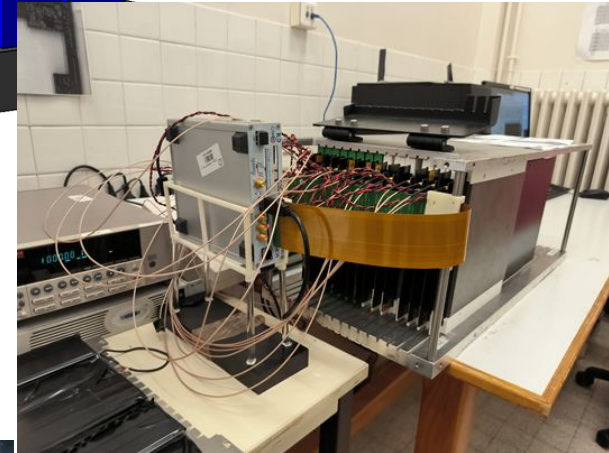
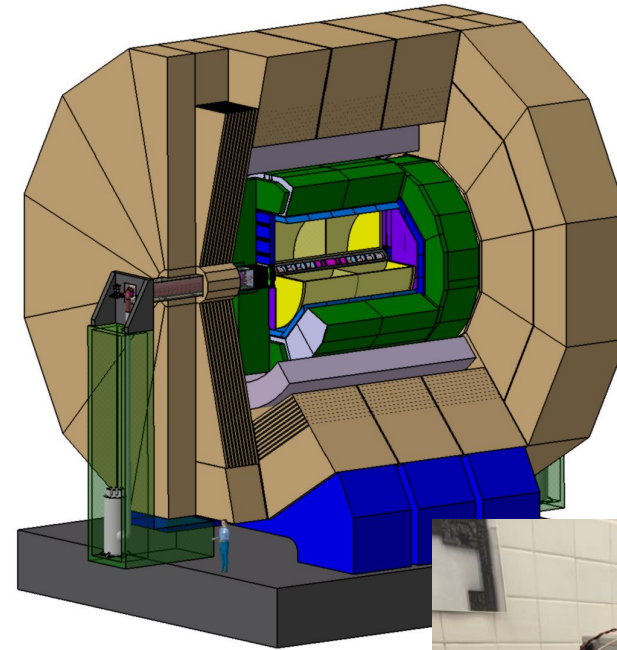
- built 10 new ASUs (18cm x 18cm) this year (years of savings)
- Testbeam
- GetROC (pka CaloROC): common readout chip for FCC calorimeters based on **SKIROC**, HGCROC, i.e., Omega ROCs

Software:

- EUDAQ compatible with custom configuration tools
- DFG-ANR: CALO5D
- Machine Learning in Particle Flow
- Use of timing information in particle flow
- with **Key4hep** tools

Development driven by:

- **FCC-ee (cooling)**
- **Ship (2x2 ASUs and 3x3mm cells, reco in key4hep with ACTS)**
- **Lohengrin**
- LUXE



Detector Development DRDCalo

SiW Electromagnetic Calorimeter (LLR, IJCLab, Omega, DMLab)

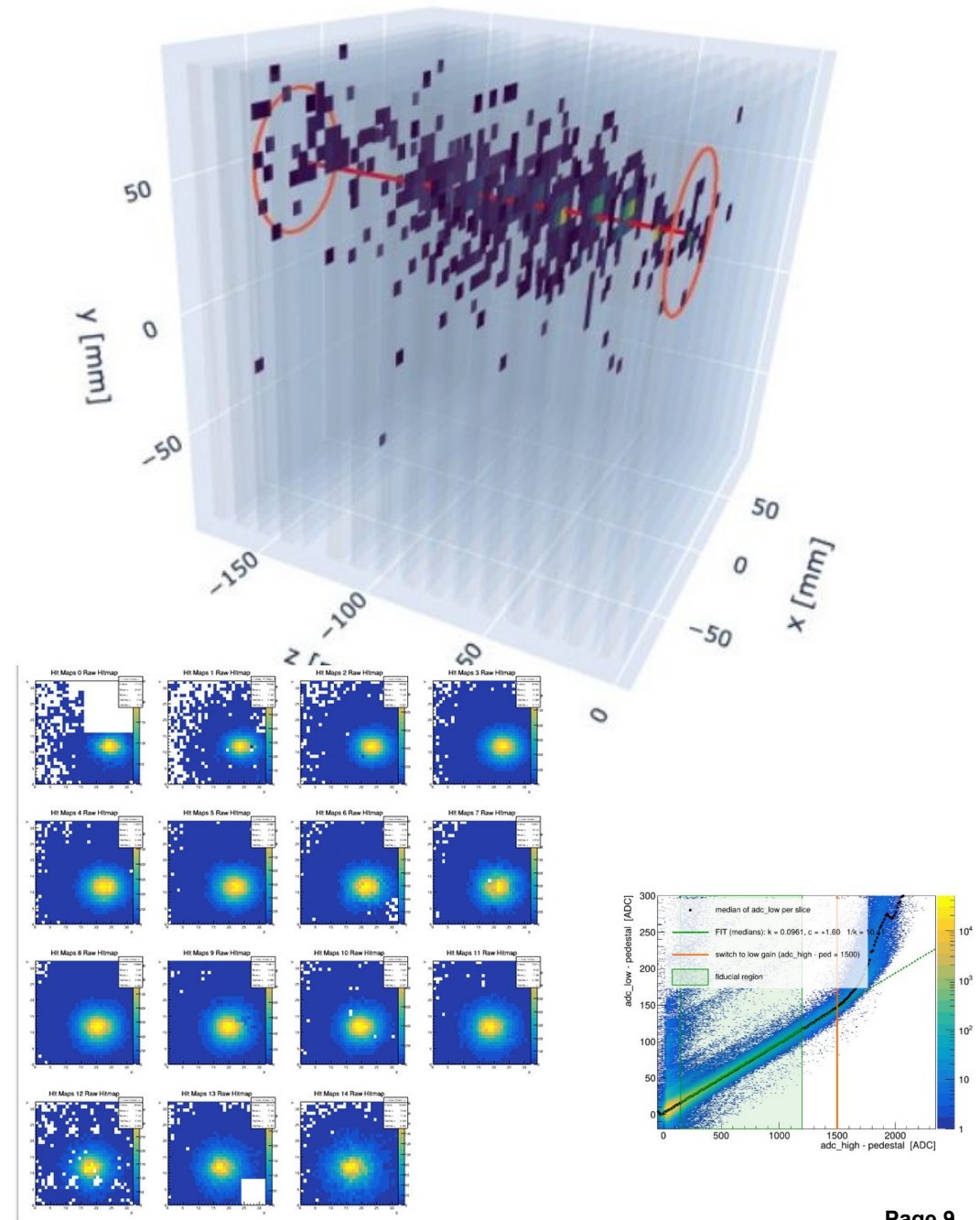
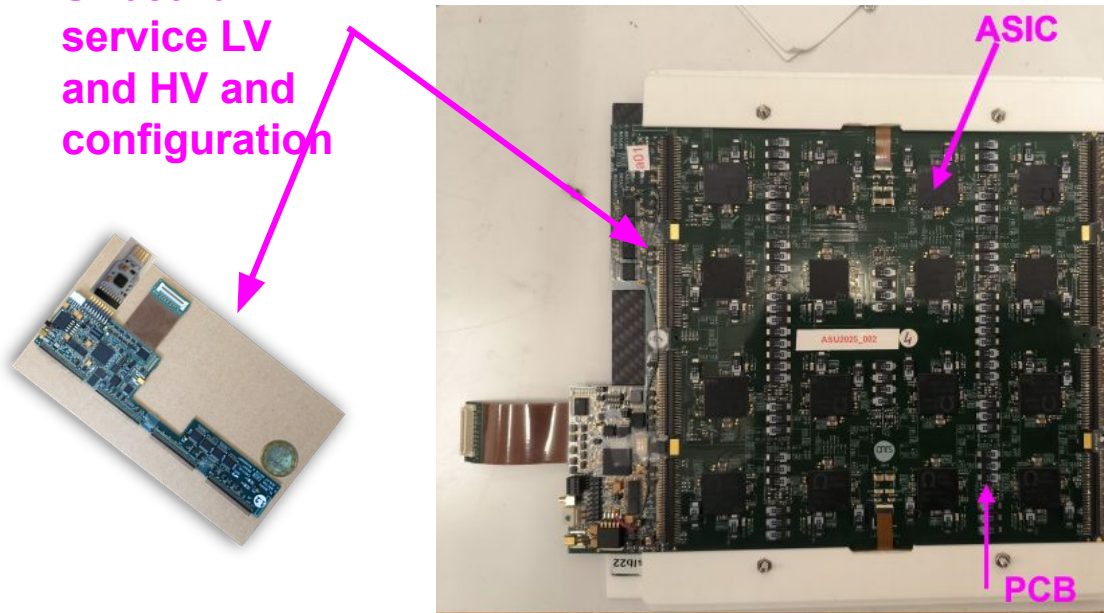
Small series construction and testbeam (CERN North Area 2026):

- no signs of delamination
- less dead cells (order of magnitude improvement to permil)
- no collective effects at higher energy (120GeV)

Testbeam 2026:

- quick setup order of a couple of hours
- 15 layers with 10 new layers (assembled 2026)

SLboard:
service LV
and HV and
configuration



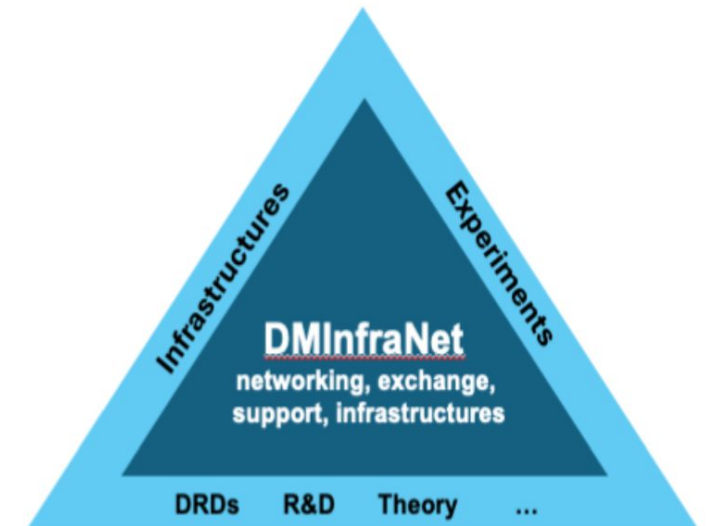
DMInfraNet

Rational:

- European strategy for particle physics focuses much on flagship colliders (HL-LHC, future flagship colliders, ...)
- Large variety of theoretically motivated dark matter candidates, ranging over several orders of magnitude in mass and interaction cross-section very different experimental approaches employing different technologies a lot of very diverse technical expertise at various places
- In addition, efforts growing in size and complexity – i.e. more and more difficult for individual (small) institutions to realise experiments – need for increased collaboration.

Ideas:

- Mutual support for existing and future projects
- Identification of common interests, sounding board for ideas, needs, expertise
- Access to infrastructures, strengthening of competence centers
- Communication structures and collaborative tools
- Joint solutions for common questions (software, data management, ...)
- Education aspect
- Increased strategic weight in Europe



DMInfraNet

Document ([arxiv:2504.01688](https://arxiv.org/abs/2504.01688)) scope and aim:

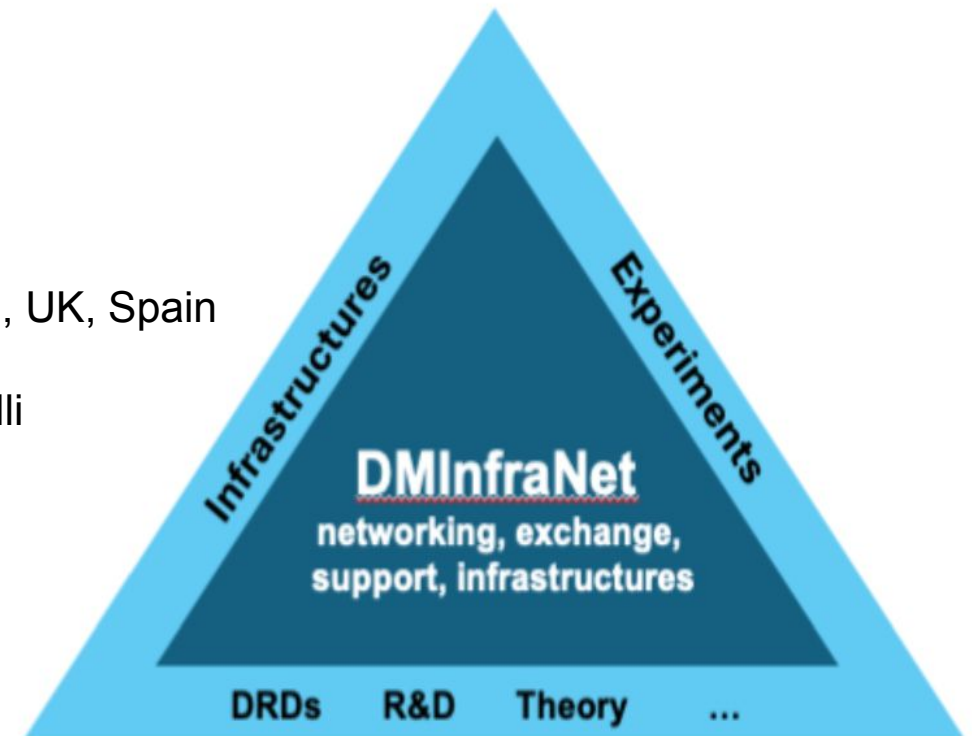
- Document specifies underground facilities, accelerator-related facilities, connections to DRDs, concrete experiments, and lab / national activities
- Enhancement of iDMEu activities?
- Extension of DRD activities at higher TRL levels: implementation of existing and new technologies

Hope (dies last just ask Alemannia Aachen from 1. Bundesliga down 3 levels in 3 years):

- Recognition of the importance of dark matter in the strategy
- Easier access to CERN resources
- Possibly some budget

Limited success:

- Logo thanks to Thomas
- no publicity, but 60 authors from Austria, France, Germany, Poland, UK, Spain
- interaction and support from iDMEu
 - support from Caterina Doglioni, Silvia Scorza and Marco Cirelli
- some interactions post Ascona ESPPU meeting



DIME:

Data management and analysis for Invisible Matter Experiments

Spin-off from DMInfraNet/Seed Project for DMInfraNet:

- With DMInfraNet submitted, and no concrete recommendation in the ESG document: need for demonstrations of benefits from collaboration
idea of DIME – with a focus on data management
- Numerous projects either not specific for DM data (**PUNCH4NFDI**, EOSC, ESCAPE) or only loose link / data set collections (**iDMEu**, **DMDC@Munich**, ...)
- unified access to dark matter data, connection of efforts in DM community, and tools and workflows for efficient and experiment-overarching dark matter data analysis desired.
- DFG-ANR to be resubmitted in 11 days for 2027-2030:
 - Request: 1.2M
 - Personnel: 4 Postdocs + 2 PhD
 - Travel
 - Networking: **workshops and visitors** (not restricted to project members)

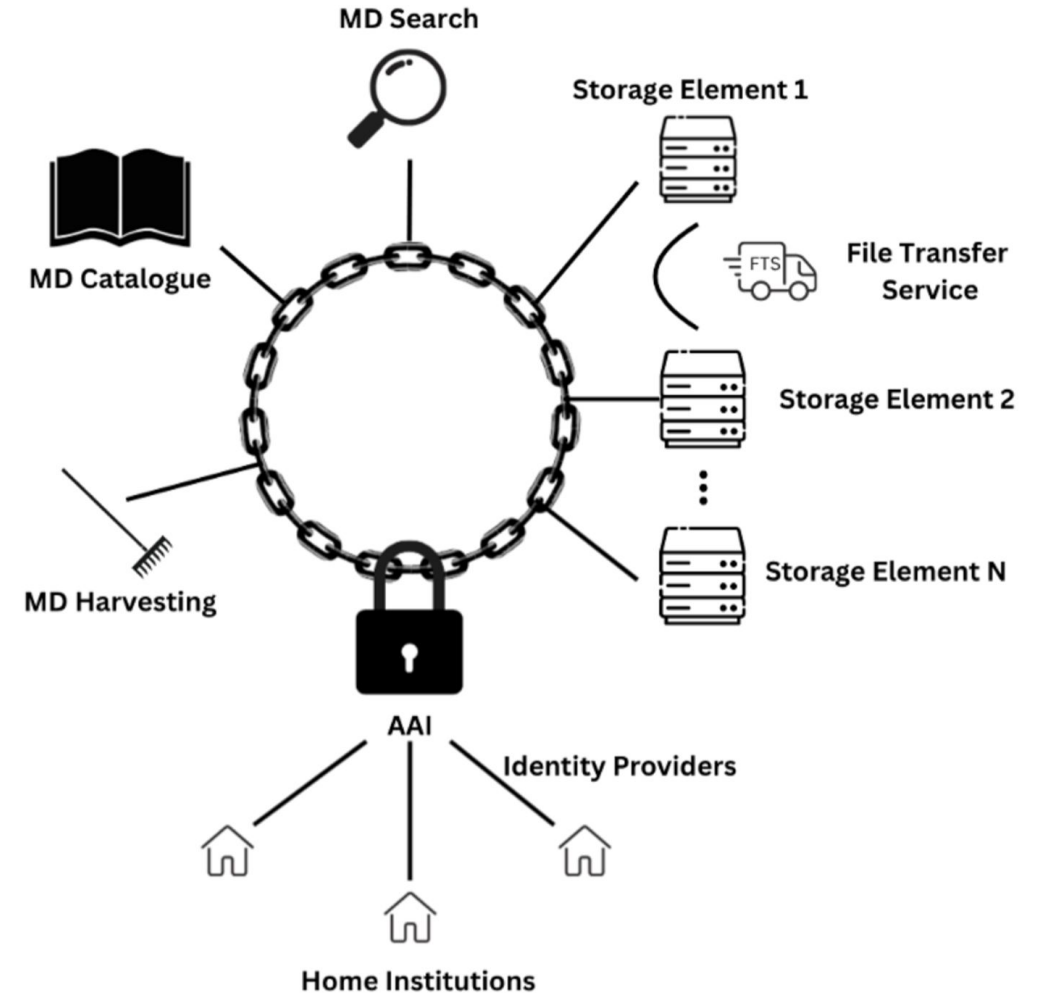


If you do not have a chance, use it as Tyrion Lannister said (kind of):

- **Objective 1:** Building on DMDC & PUNCH4NFDI, create RDM environment for various DM data sources with i) AAI, ii) searchable (meta)data catalogue building on e.g. DMDC, ILDG, iii) code repository, iv) REANA workflow installation.
- **Objective 2:** Create workflows using O1 for XLZD and MADMAX, demonstrating validity and usefulness + potential for extensions (only 2 demonstrators + pheno!)
- **Objective 3:** Perform combined DM analysis across different masses, combining several experiments (building on O1,O2)

Proponents (by lab):

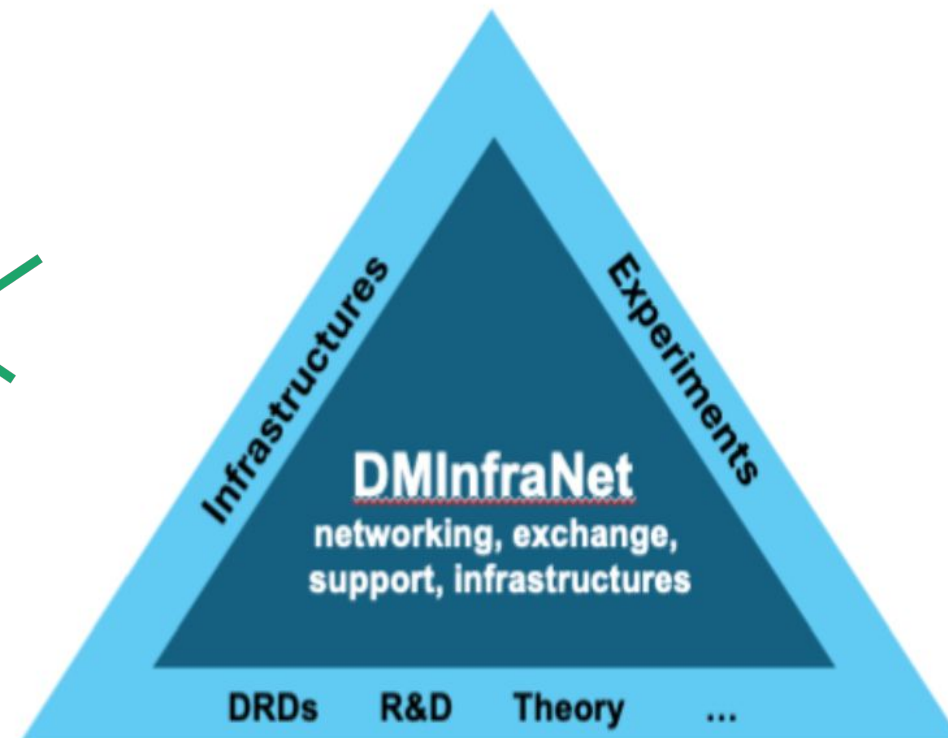
- DMLab
- DESY (Punch4NFDI)
- IJCLab Orsay (MADMAX)
- LPNHE Paris (Xenon/XLZ/Darwin)
- Bonn (Lohengrin)
- Siegen (Lohengrin)
- TUM Munich (DMDC)
- LPSC Grenoble (Phenomenology)



Summary



Key4hep*



Infrastructures and Initiatives:

- Existing: PUNCH4NFDI, Key4hep
- Attempted: DMInfraNet, DIME

No obvious road to a bag of money, but in the words of Dave Ramsey: baby steps to success!