ARTIFACT

ARTIFACT meeting

IPAC Satellite meeting

A Ghribi (CNRS/GANIL)
on behalf of the ARTIFACT network

Deauville - May 19th 2026

Outline

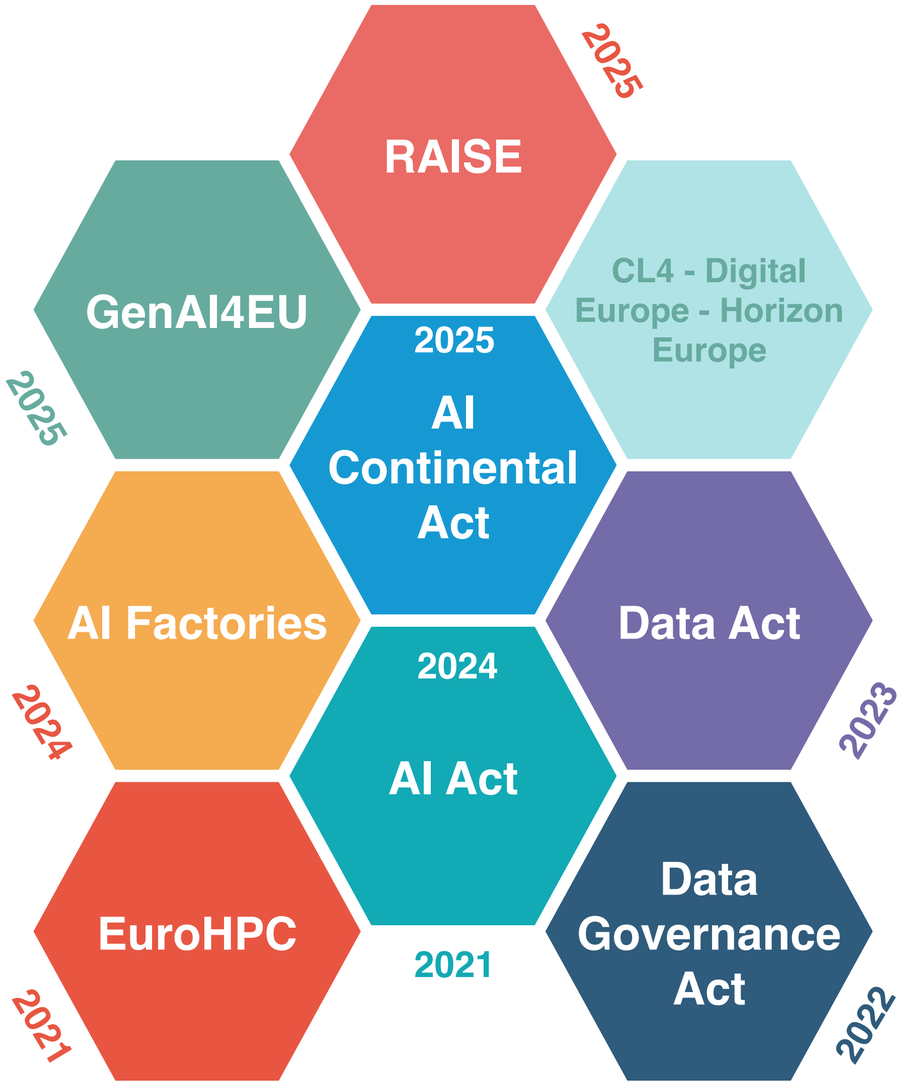
1. **Synergy in EU RI**
2. **Funded EU Projects**
3. **Projects in preparation**
4. **ARTIFACT Resources**
5. Discussion

Synergy in EU RI : a new strategy 3

From the AI Act to RAISE

- Since 2021, the EC has adopter a series of measures that aim to :
  - Accelerate the adoption of AI in economy and research
  - Position the EU as world leader in ethical AI
  - Facilitate access to data, compute and talents

➡ More than a 1 billion € dedicated to AI development
➡ The rising need of AI in science



From an investment gap to a EU strategy

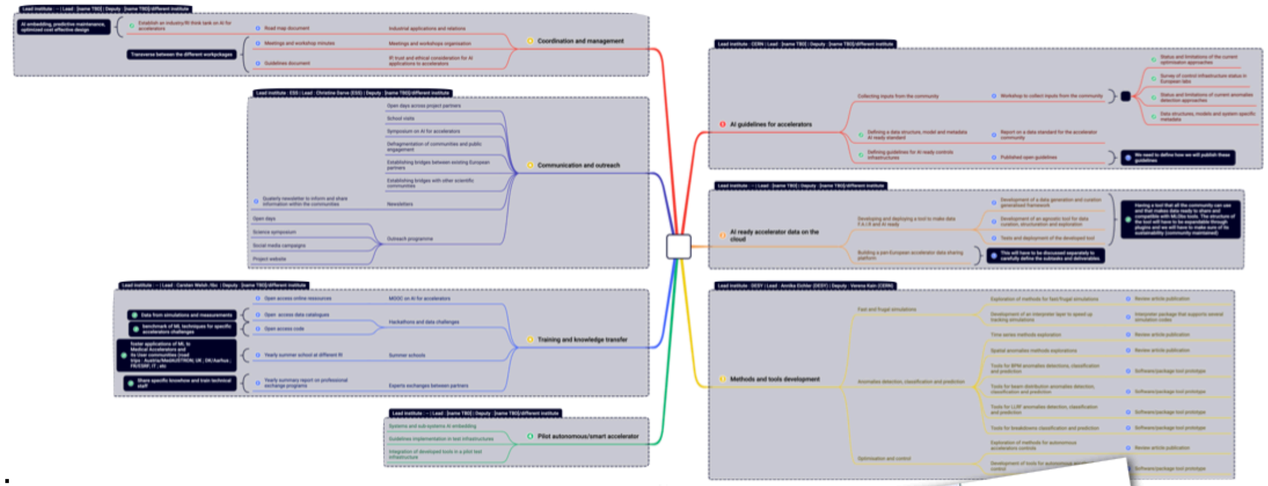
~ 2024 — Two EU workshops bring the field together

Motivated (mostly young) researchers map the gap

Visibility of the field, shared priorities emerge

Result : First EU project submitted under the ARTIFACT name

Outcome : not selected — too broad, wrong timing, did not align wi the Commission strategy



Summer 2025 — **Pivot : divide and conquer**

Strategy : identify specific calls, concentrate in resources, open to other disciplines (medicine, biology, environmental science, robotic

➡ **ART**ificial **I**ntelligence **F**or **A**ccelerators, user **C**ommunities and associated **T**echnologies

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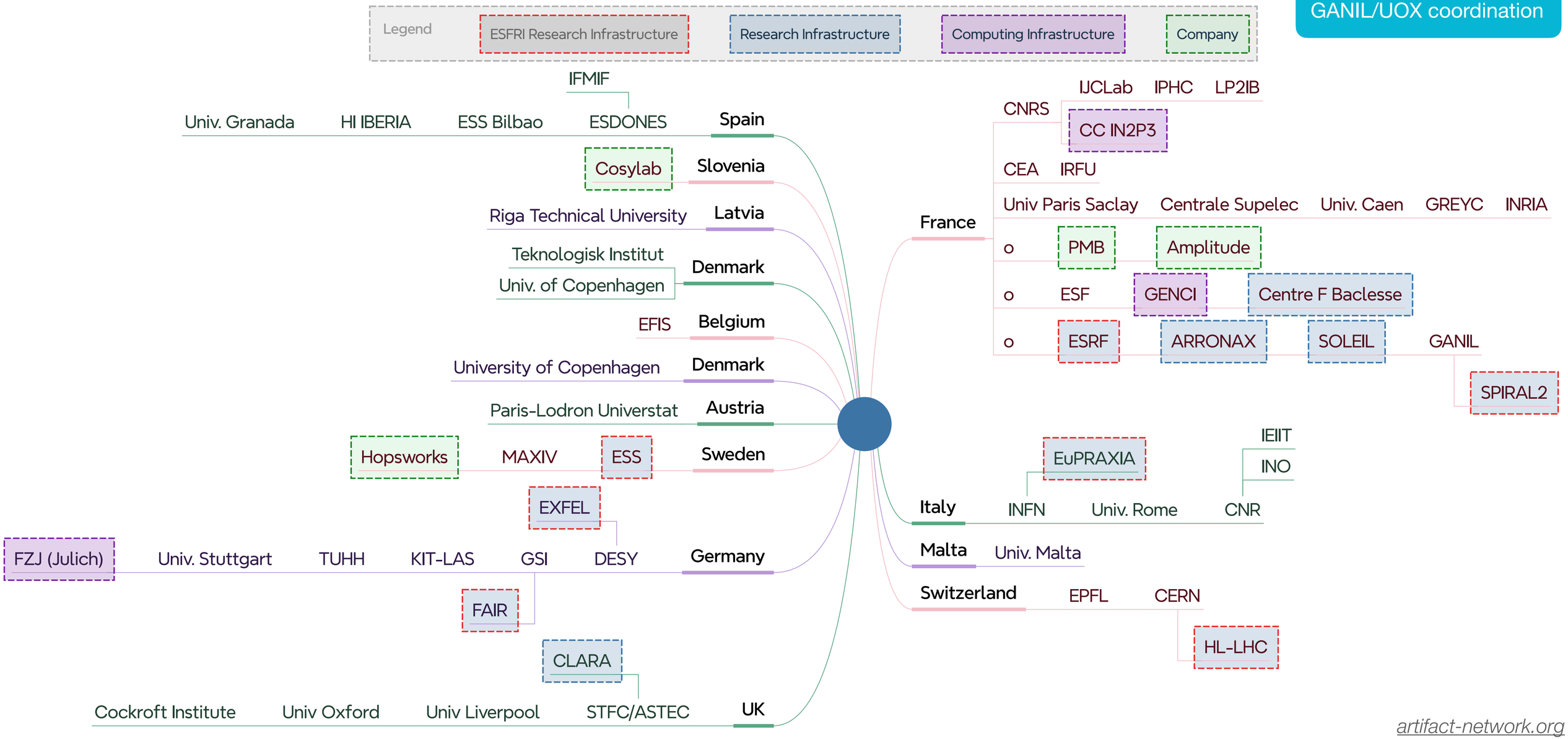
Strategy : identify specific calls, concentrate in resources, open to other disciplines (medicine, biology, environmental science, robotics)

> *We stopped trying to do everything at once. We identified what mattered most and built targeted proposals around it*

The result: 43 M€ submitted, 18 M€ accepted
5 calls driven or co-driven
3 projects accepted (direct ARTIFACT)
+2 with indirect connections

ARTIFACT - A Federated Strategy

40+ partners
14 countries
GANIL/UOX coordination



artifact-network.org

ARTIFACT pillars, timeline and architecture layers

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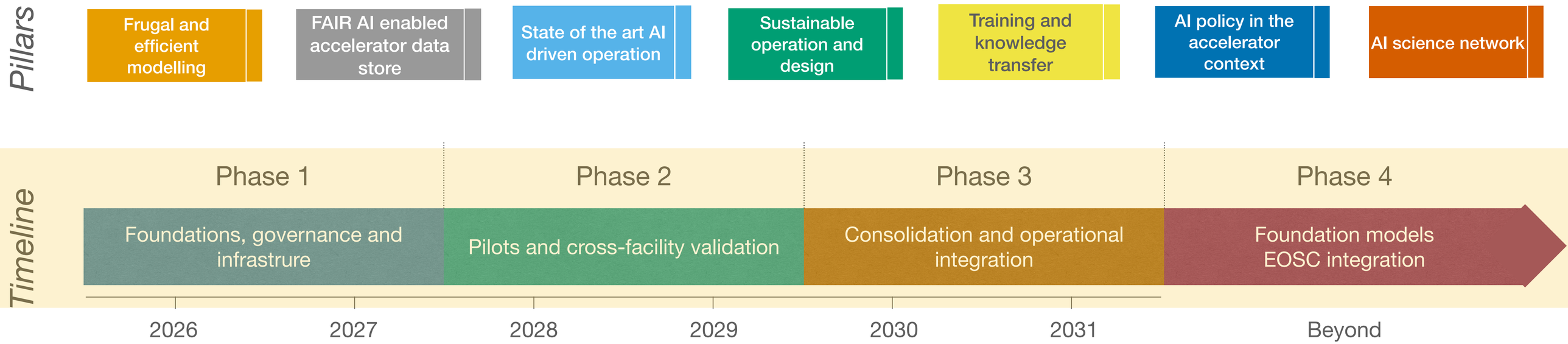
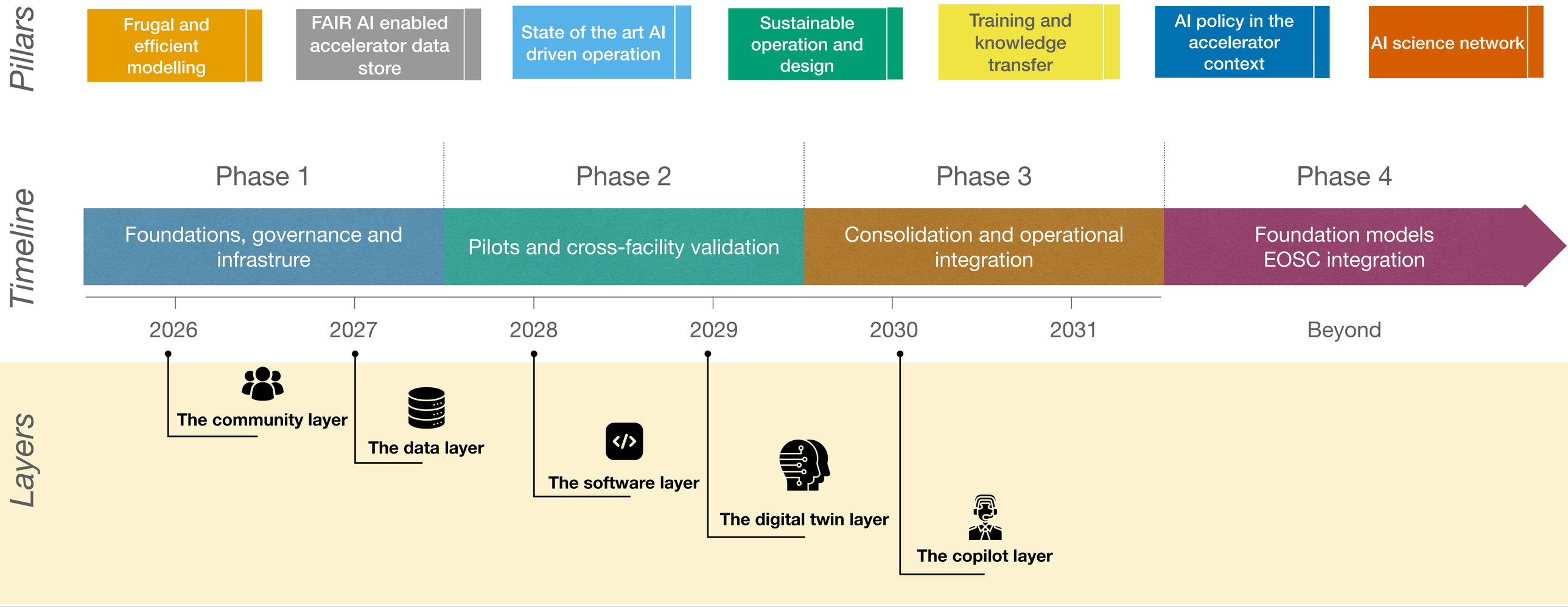


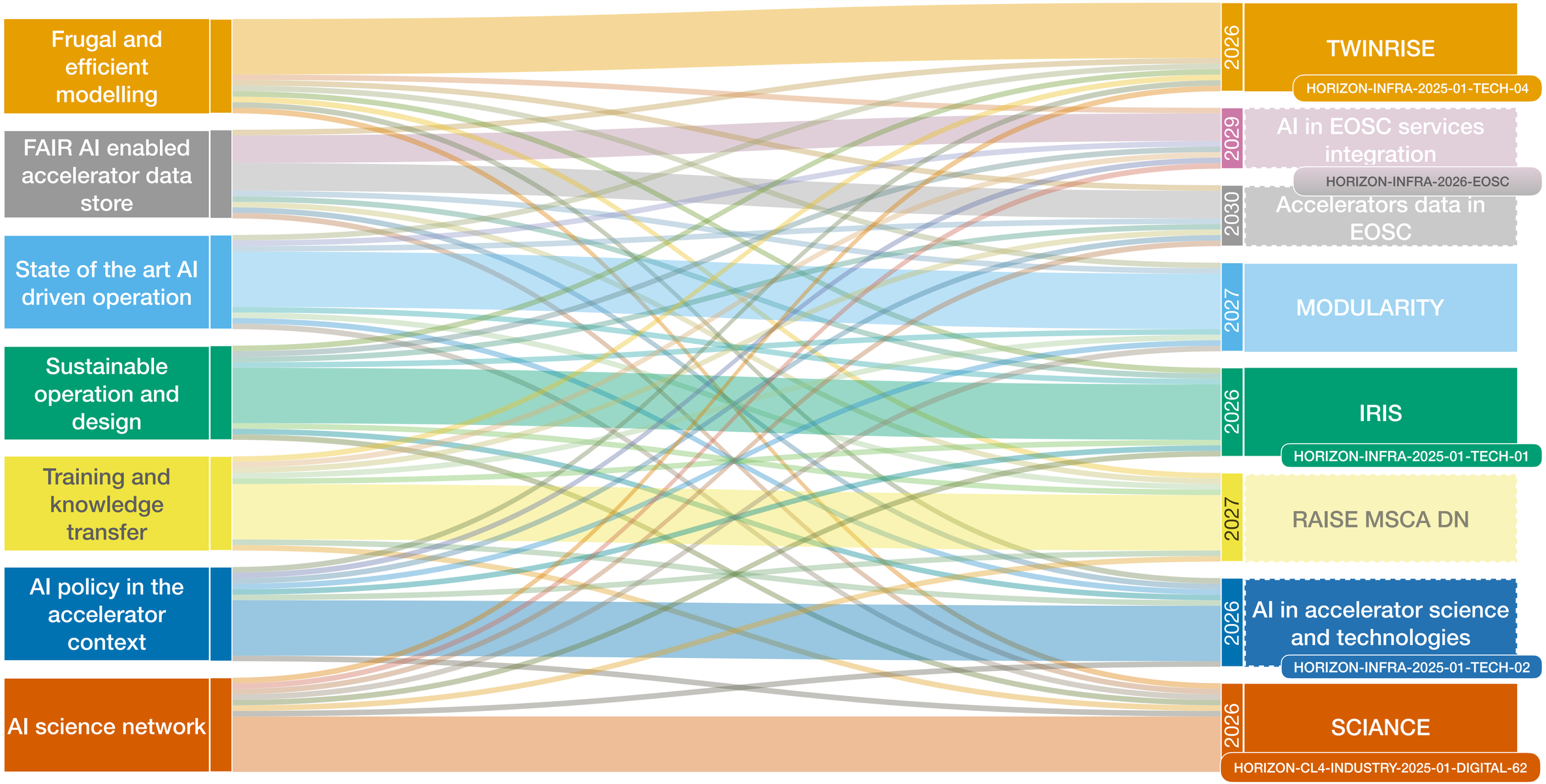
ARTIFACT pillars, timeline and architecture layers



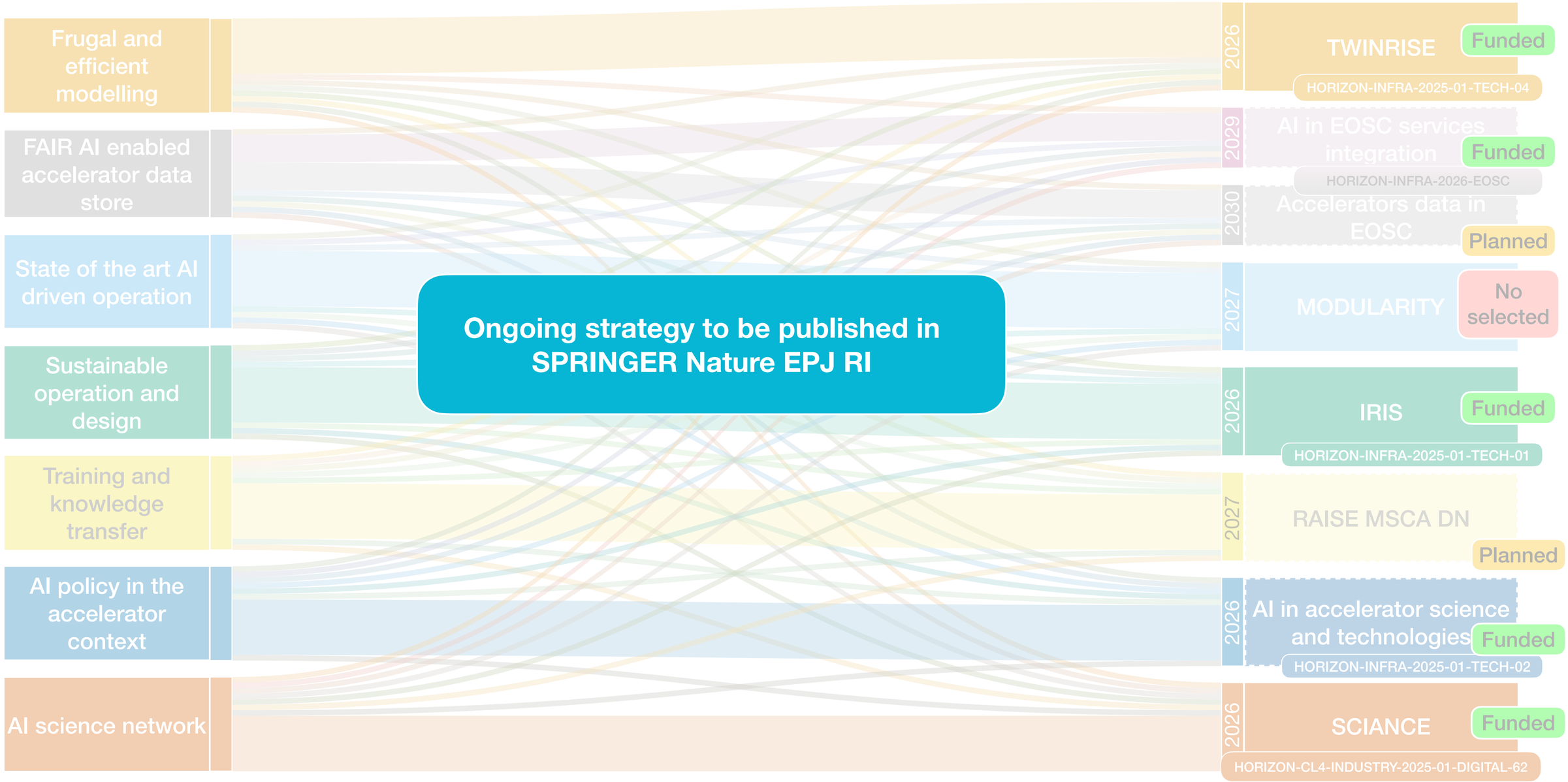
Six Strategic Pillars — From Data to Policy

- Frugal and efficient modelling
- FAIR AI enabled accelerator data store
- State of the art AI driven operation
- Sustainable operation and design
- Training and knowledge transfer
- AI policy in the accelerator context
- AI science network

Six Strategic Pillars — From Data to Policy



Six Strategic Pillars — From Data to Policy



What remains open

What we do not fully cover (yet) :

- **Training**
  no dedicated doctoral network yet
- **Control system integration**
  EPICS/TANGO/… integration remains facility-specific

  WG - Modularity (IJCLab lead)
- **Foundation models for accelerators**
  no cross-facility pre-trained models exist yet

  TwinRISE to unlock the main barrier
- **EOSC integration**
  AI4EOSC accelerators cases will be in preparation in 2027

  Preparation begins this year as well
- Extended **Virtual distributed facility** studies
  Theoretical studies much needed

  The intersection between state of the art AI explainability and physics
- The **User Communities** dimensions
  under represented

  The DN is an excellent opportunity to increase this aspect

Funded EU Projects

2

TwinRISE

2.1

Trusted Digital Twins for Research Infrastructures

Call	HORIZON-INFRA-2025-01-TECH-04
Proposal	#101287548
Duration	48 months
Coordinator	CNRS (UAR GANIL - Adnan Ghribi)
Funding	~ 10 M€
Status	Grant Agreement Preparation
Kick-off	**January 1st 2027**

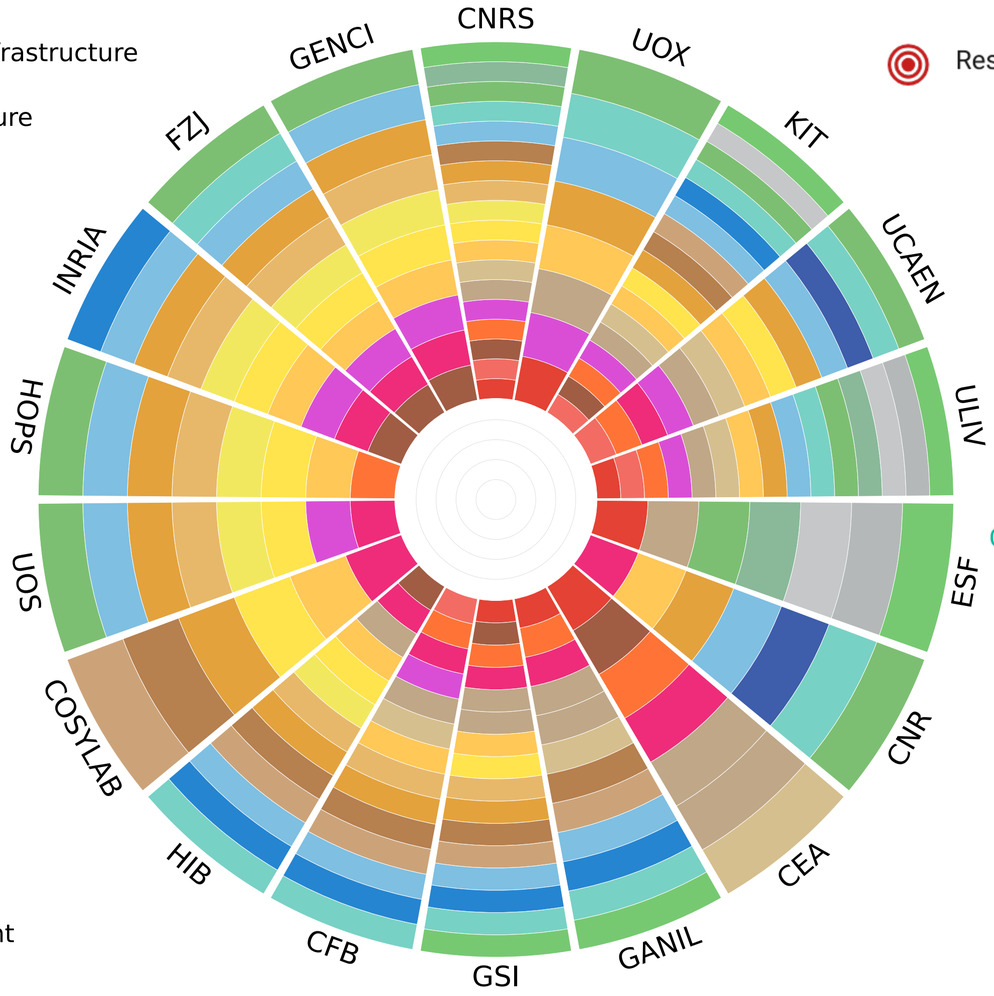
TwinRISE : The Consortium

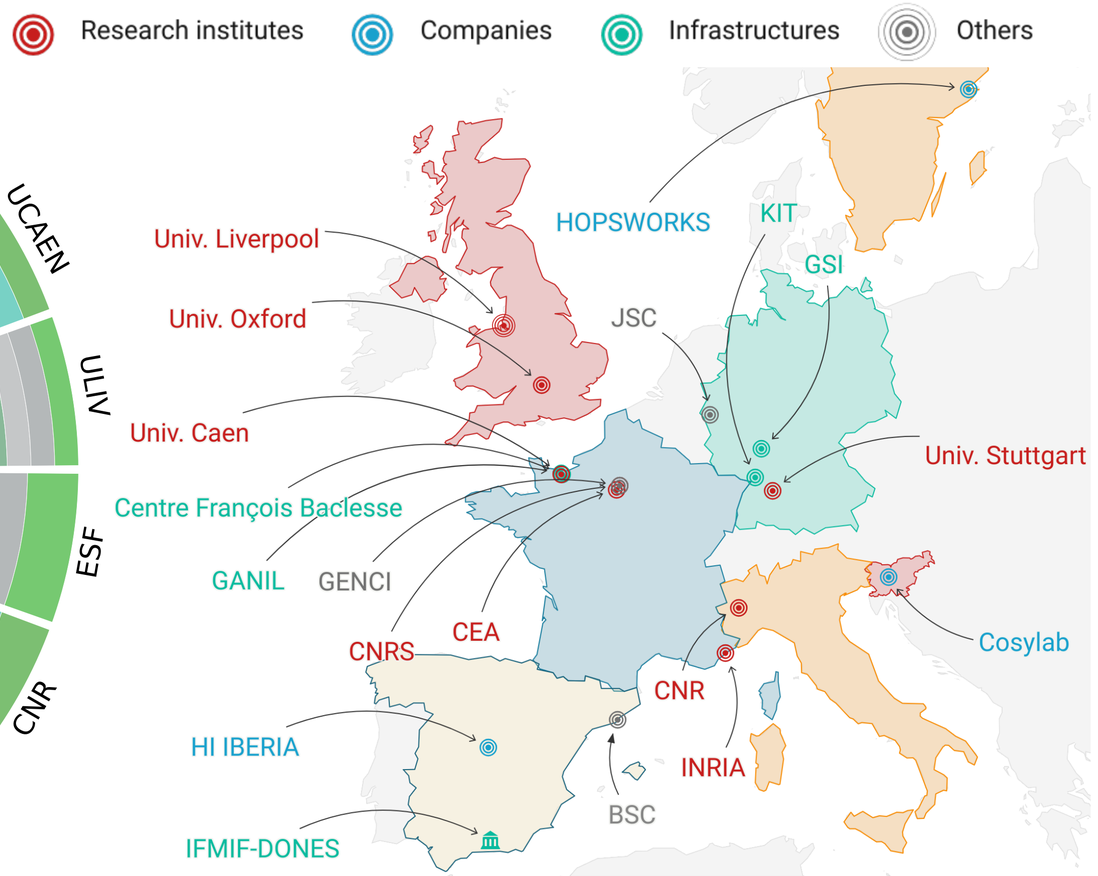
Service
- Particle Accelerator Infrastructure
- Health Infrastructure
- Computing Infrastructure
- Data Sets
- Data Storage
- Training Centre

Technical skills
- Medical Imaging
- Accelerator Physics
- Medical Treatment
- Data Science
- Data Engineering
- Computing
- Big Data
- Software Engineering
- Control Systems
- Embedded Systems

AI skills
- Machine Learning
- Federated Learning
- Explainable Ai
- Surrogate Models

Transverse
- Training
- Technology Transfer
- Socio Economics
- Communication
- Eu Project Management





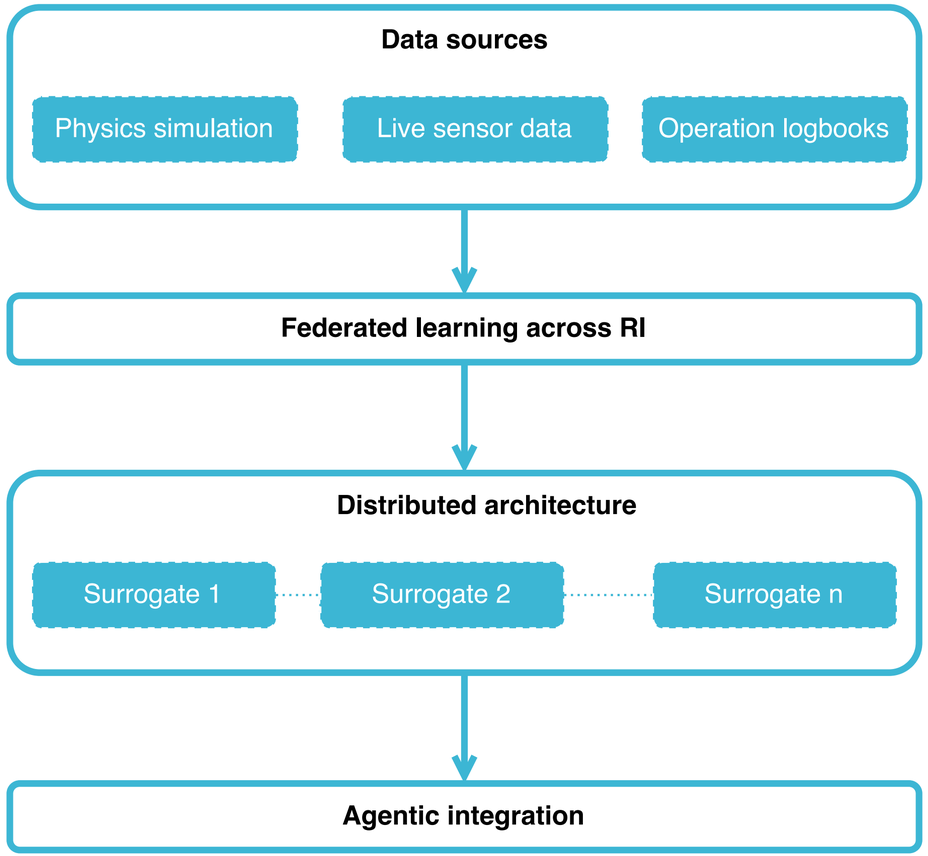
• 18 beneficiaries • 1 associate partner • 7 countries

What is a TwinRISE Digital Twin ?

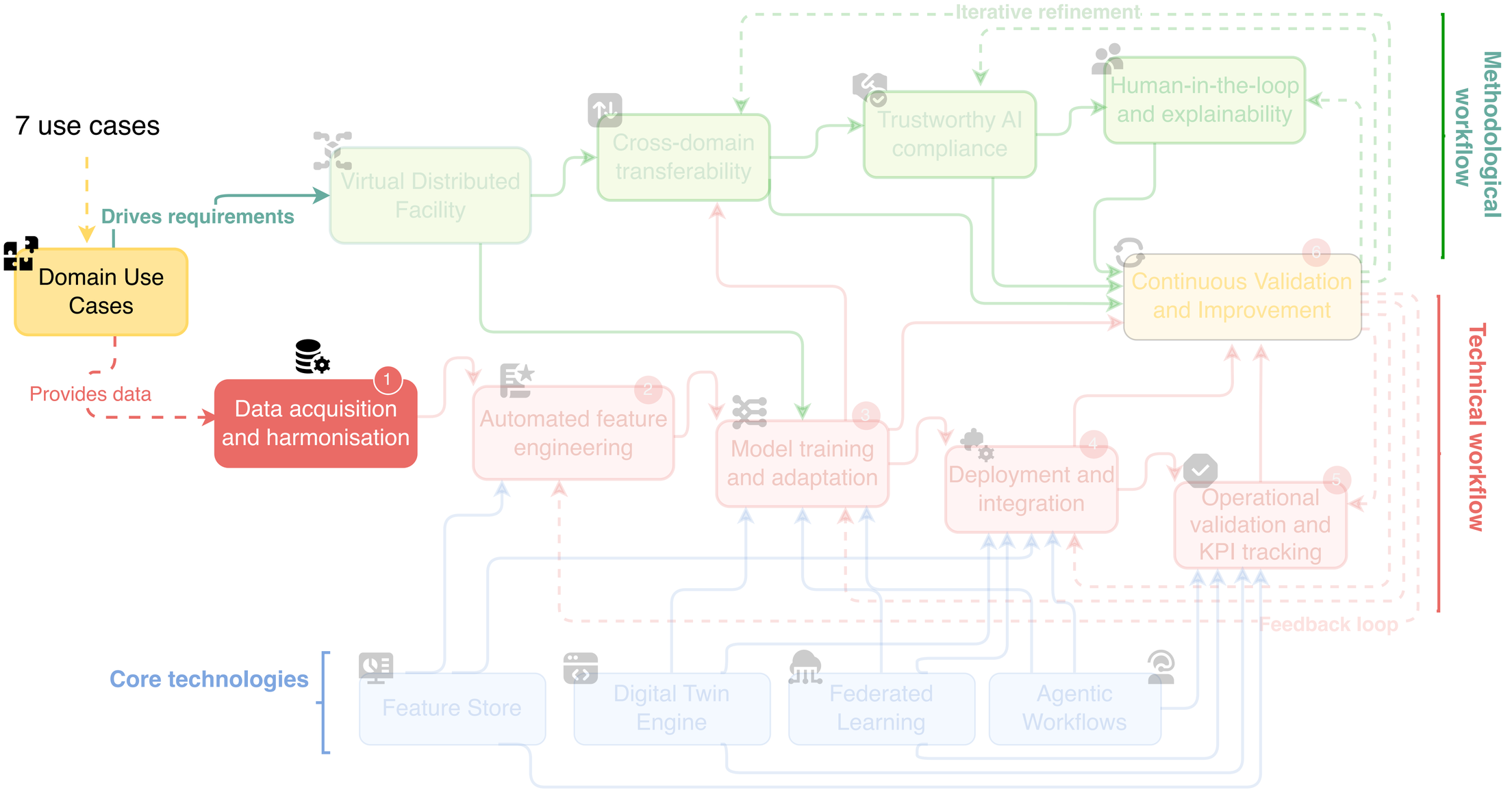
A twin is a digital **representation of reality**. Our twins combine **physics simulations**, **ML-based surrogate models**, and **live sensor data** into a real-time virtual replica of a facility.

TwinRISE adds three critical properties :

- **Federated Learning** (FedBioMed) — Train across sites without sharing raw data (data sovereignty preserved)
- **Explainability** (XAI) — decisions must be interpretable by operators and auditable under the EU AI Act.
- The **distributed facility** paradigm — pilot twins architectures must allow the combination of several twins together while retaining causality



TwinRISE Approach



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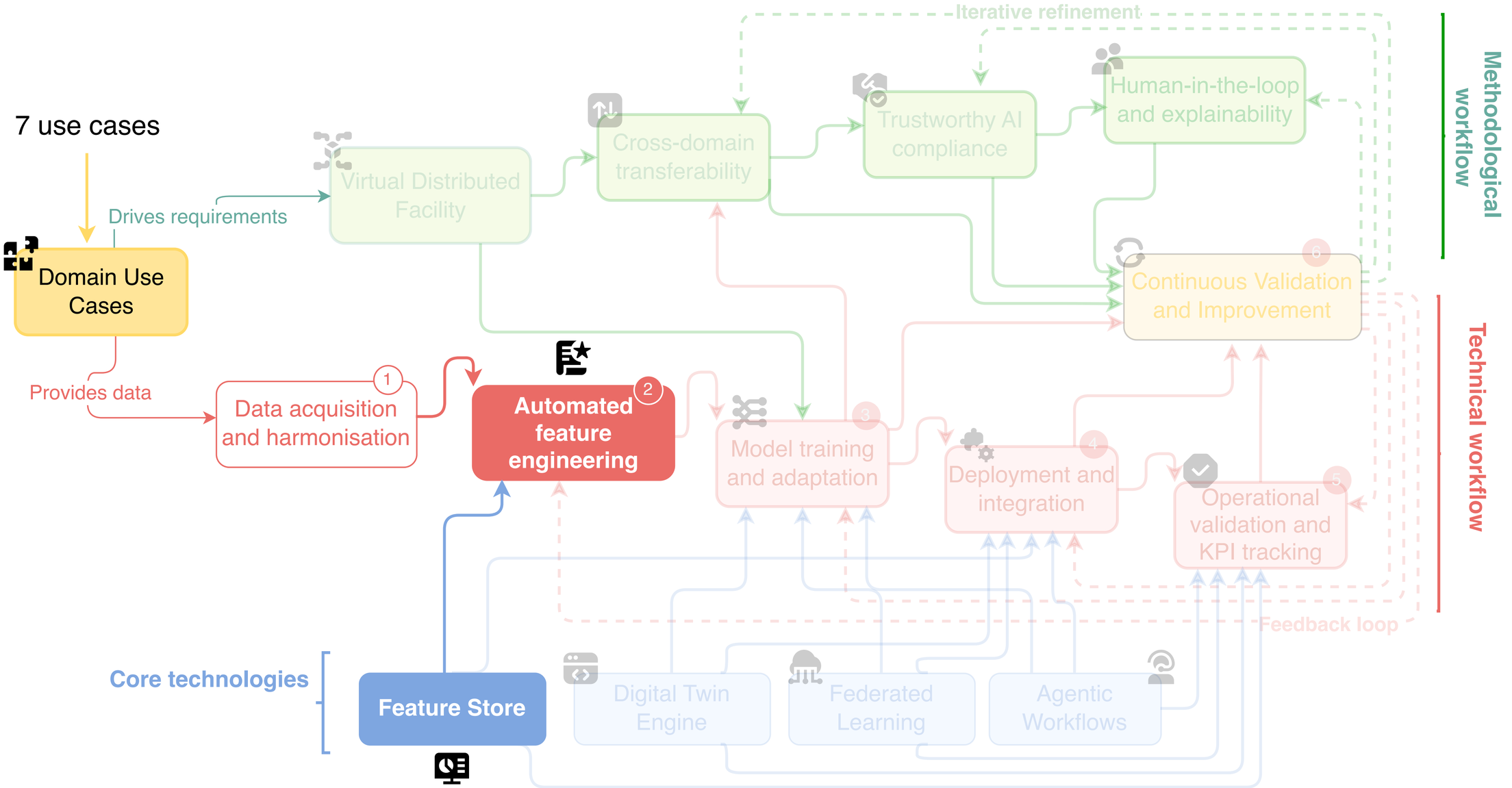

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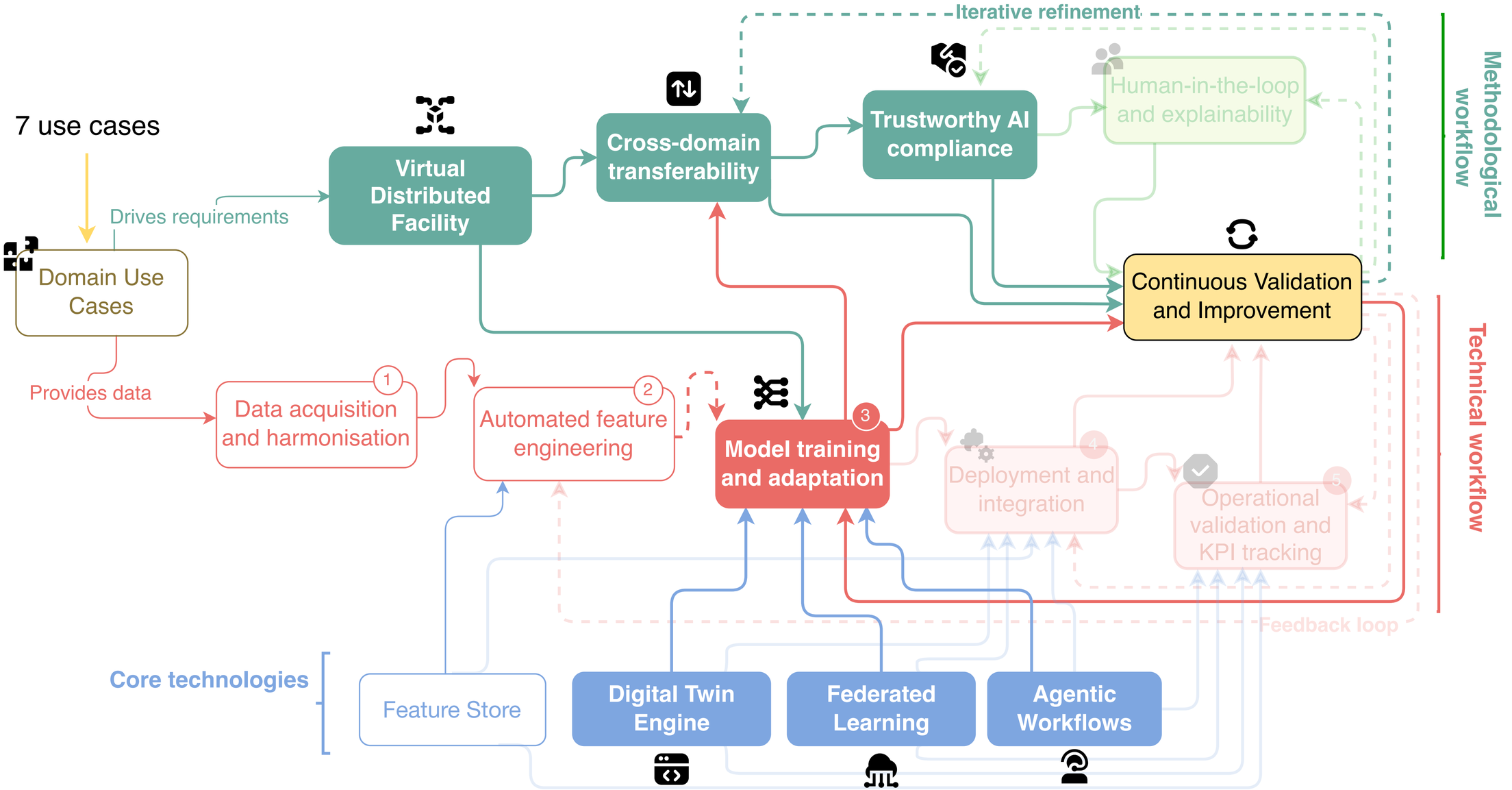

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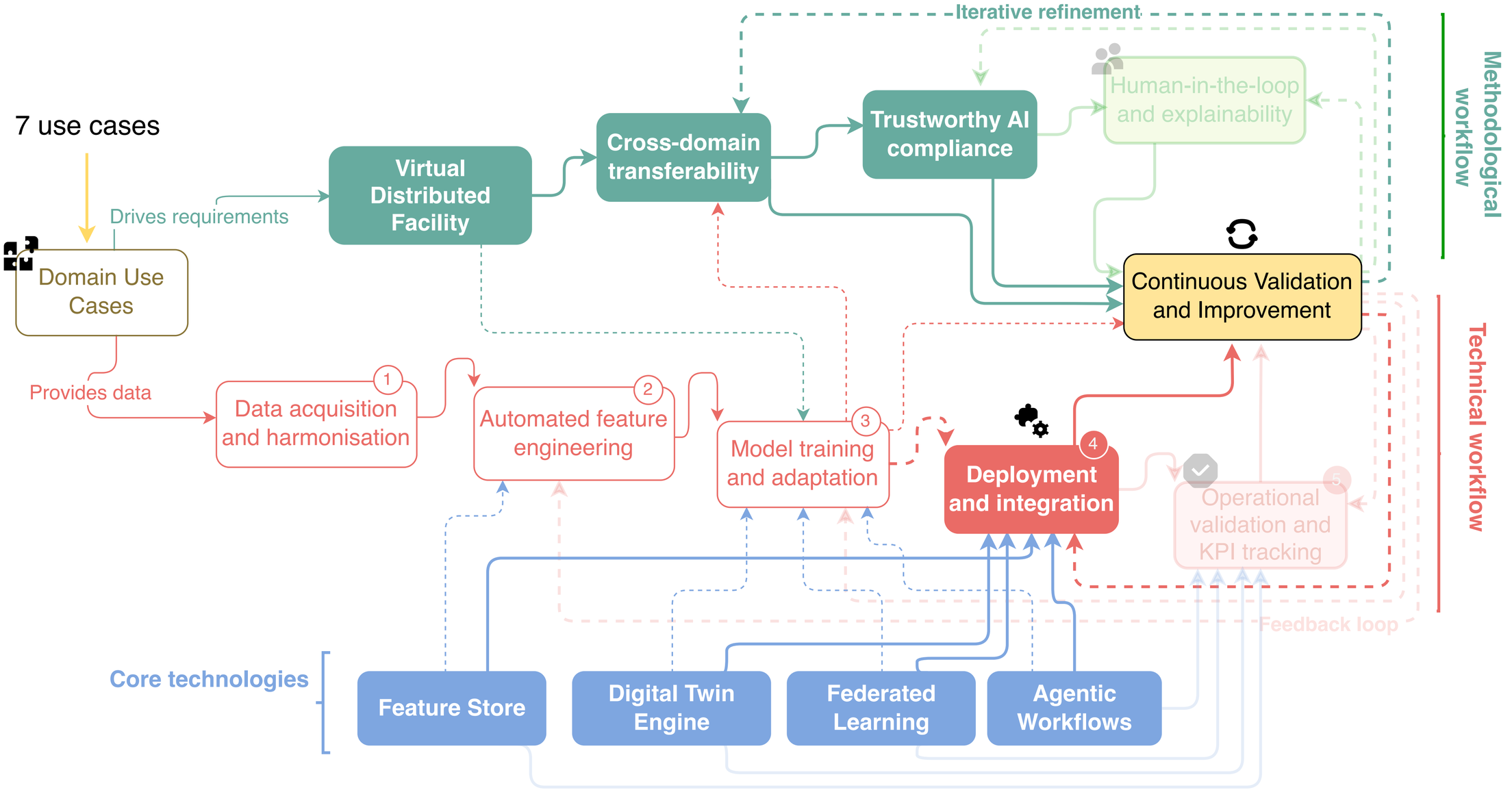

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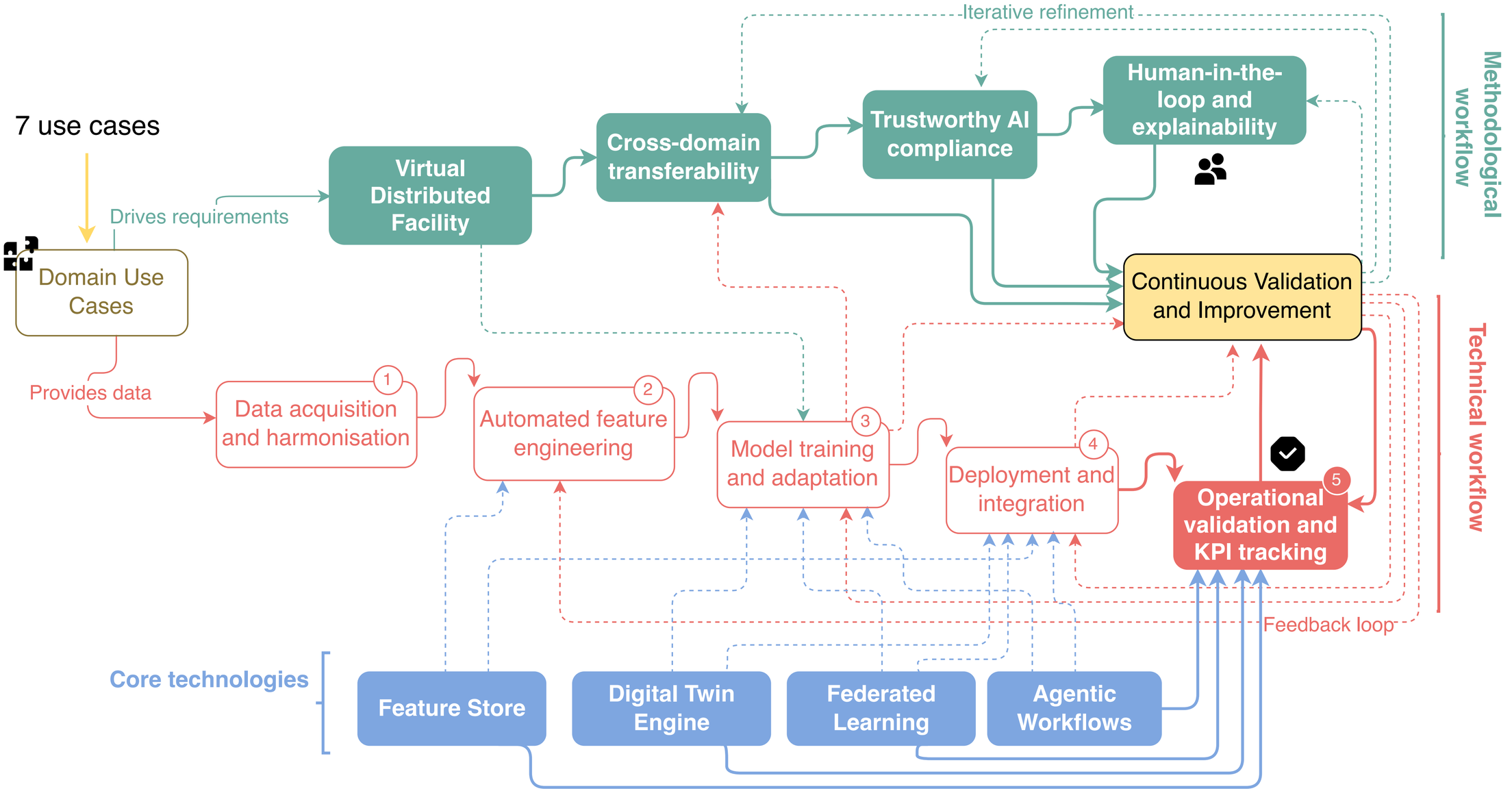
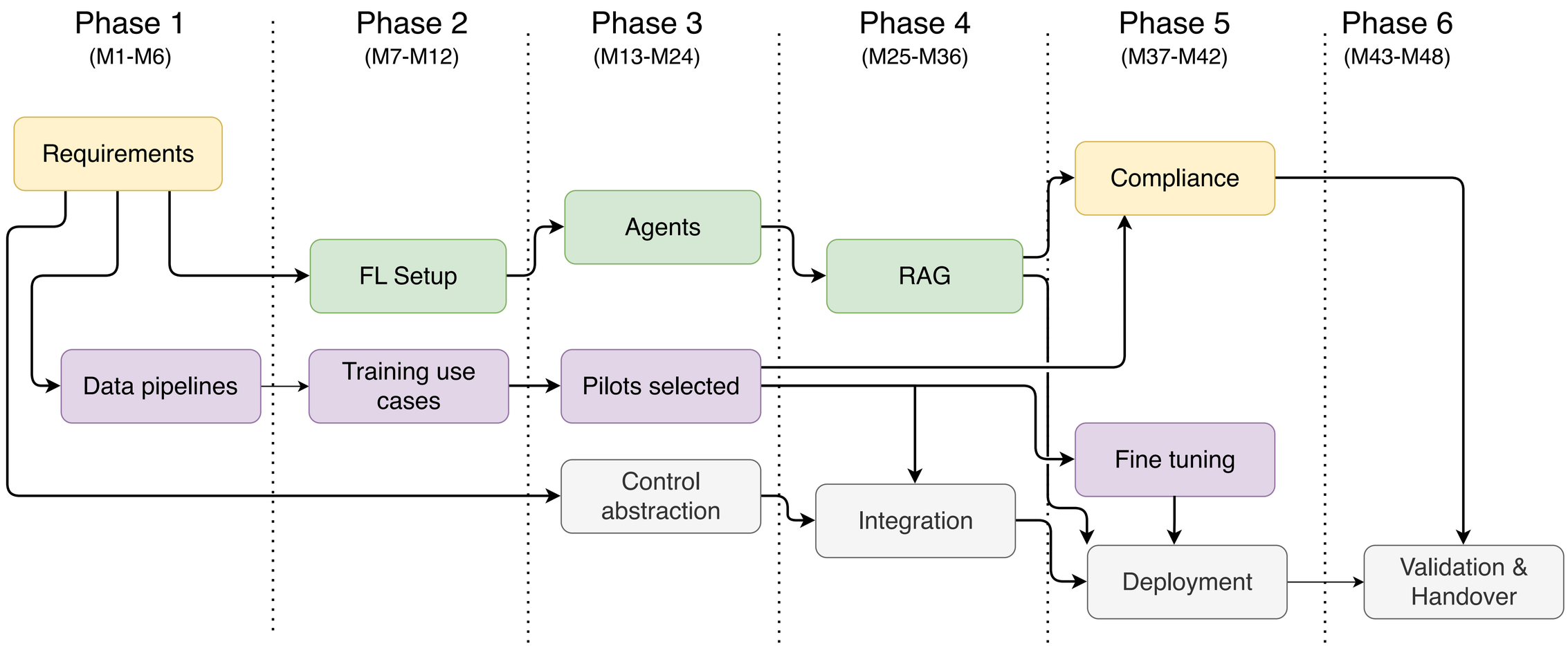


Phasing

TwinRISE - Trusted AI-Generated Digital Twins for Research Infrastructures



TwinRISE Core Technologies

- Hopsworks **Feature Store**
  - Community data store ready
  - Feature store ongoing deployment @CCIN2P3 [https://www.hopsworks.ai/]
- Digital **Twin Engine**
  - One of InterTwin EU project outcomes [www.intertwin.eu]
- **FedBioMed** federated learning framework
  - Transfer from medicine to accelerators
- **XAI tools** development
  - Transfer from high risk fields to accelerators and medicine

HOPSWORKS

interTwin

Fed-BioMed

Collaborative learning in healthcare

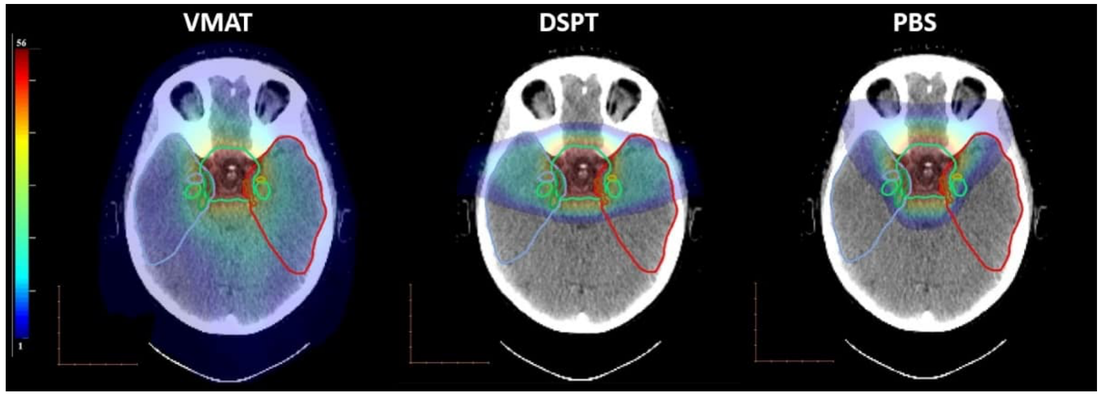
Open, Transparent and Trusted Collaborative Learning for Real-World Healthcare Applications

TwinRISE Domain Use Cases

7 pilots, 3 clusters

Cluster 1 — Medical physics [lead : CFB]

- Dose from enhanced scintillation detectors
- MRI to CT neural translation
- Treatment optimization



CT-MRI-based delineation of brain structures. Left and centre: traditional radiation therapy. Right: Pencil Beam proton therapy (PBS) - Exemplifying the low radiation of the latter technique, one of our case studies [1]

Challenges

- ➡ MRI to CT image reconstruction/delineation
- ➡ 3D dose distribution reconstruction
- ➡ Treatment outcome prediction using blood biomarkers

[1] PTCOG – ParticleTherapy Co-Operative Group,Particle Therapy Facilities in Clinical Operation(Public), 2025.

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Cluster 1 — Medical physics [lead : CFB]

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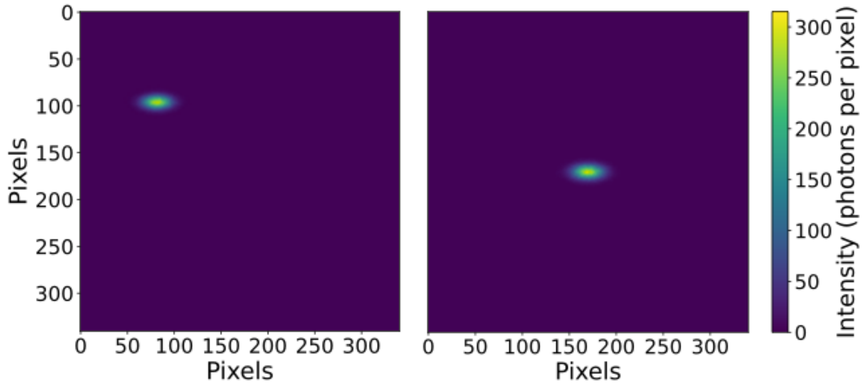
Cluster 2 — Beam operation [lead : KIT]

- Spectrometer Twin (SuperFRS - GSI)
- Energy-ware accelerator twin (KIT)
- Beam availability & control resilience (esDONES)

Challenges

- ➡ SuperFRS and SIS18 digital twin integration @FAIR
- ➡ Energy aware operation @KARA
- ➡ Resilience and efficient faults compensation @DONES

Representation of SuperFRS@FAIR - one of our case studies. Source: GSI Media Library.



Beam position before (left) and after (right) Bayesian Optimization, showing successful centering After BAX optimisation at KARA [Matzoukas+2025]

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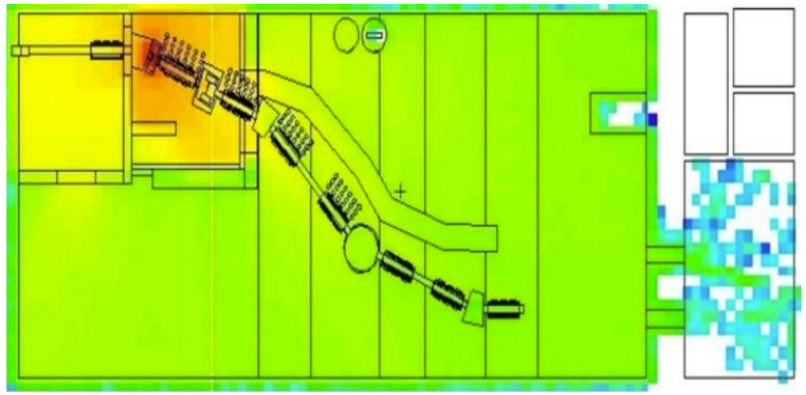
Cluster 3 — Transverse applications [lead : GANIL]

- AI enhanced dose cartography —> Radiation safety at GANIL/ esDONES & clinical dose awareness at ULIV



Neutron dose rate cartography inside S3 facility generated by the accelerated heavy ion 12C (15 MeV/ n, 45kW) when stopped at the copper beam-dump. [Credit : Manssour Fadil]

Challenges

- How to combine stochastic and deterministic approaches for rapid yet precise dose rate estimation.
- How to transfer methods between material science, radiation safety and medicine.

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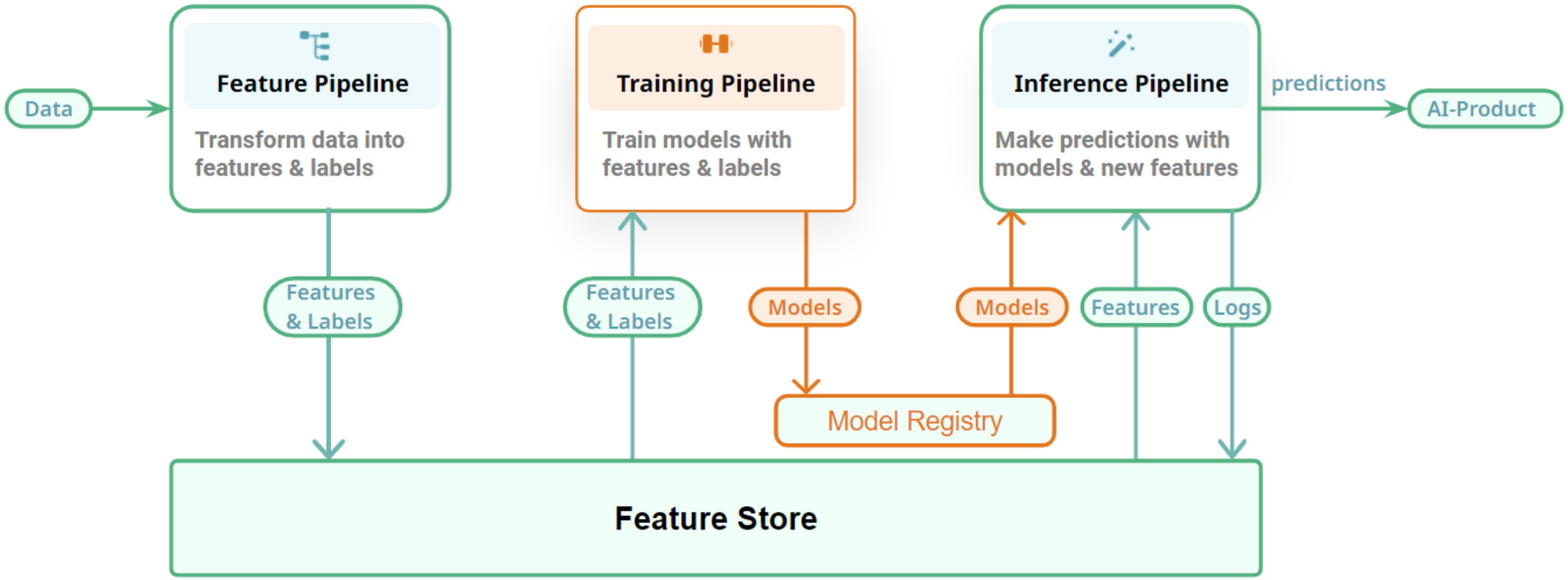
Challenges

- ➡ On premises and distant deployment
- ➡ Agentic structuration pipeline



Simplified feature store architecture [www.hopsworks.ai]

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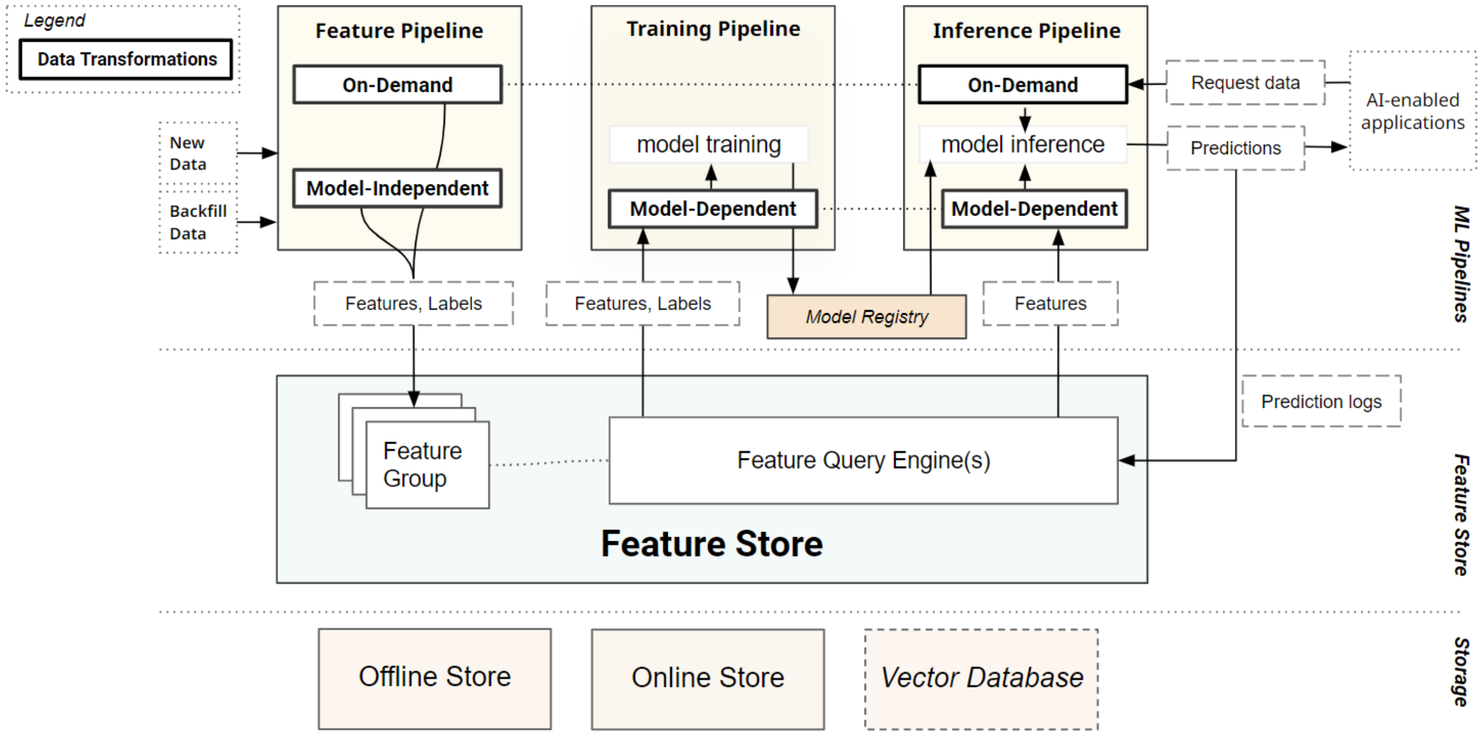

Detailed feature store architecture [www.hopsworks.ai]

TwinRISE Core Technologies

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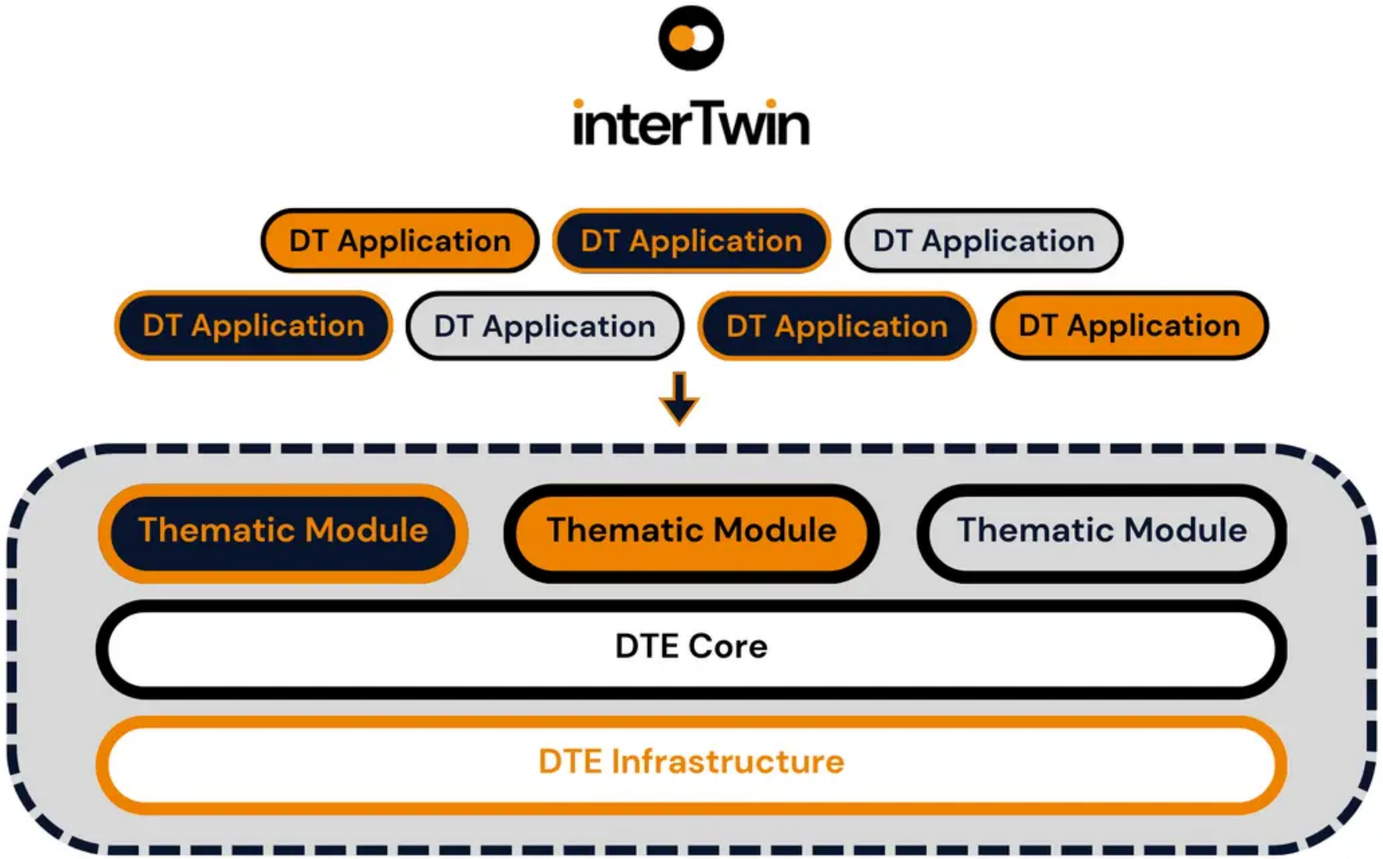
- Digital **Twin Engine**
  - One of InterTwin EU project outcomes

Challenges

- ➡ Domain extension
- ➡ Distributed learning for HPC
- ➡ MLOps integration



Digital Twin Engine layers with infrastructure modules, core modules and thematic modules [www.intertwin.eu]

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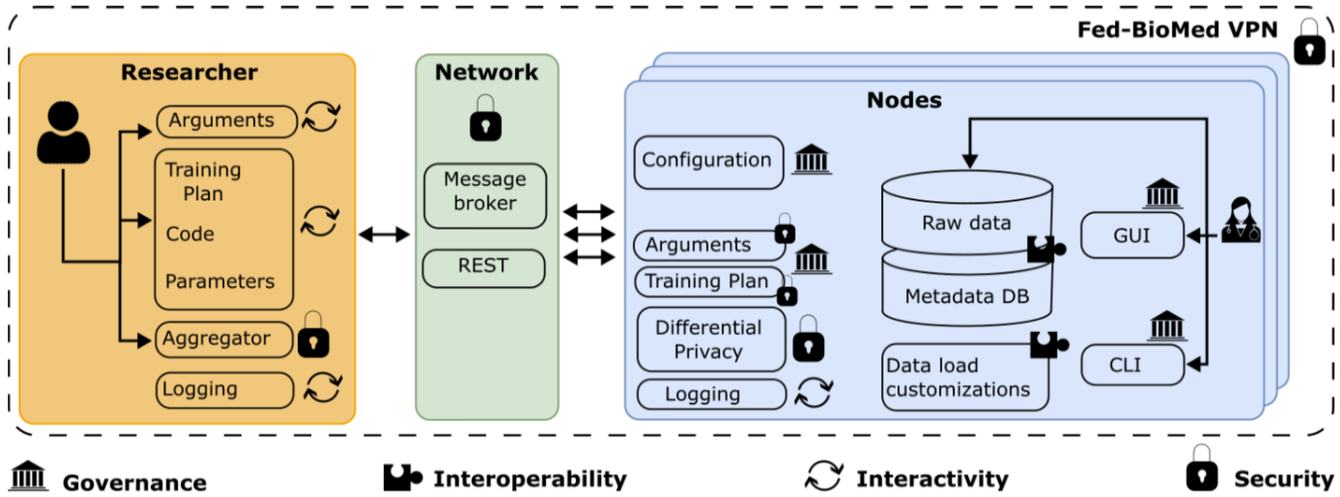

High-level architecture and design pillars of Fed-BioMed [Cremonesi+2023]

Challenges

- ➡ Interoperability with accelerator data standards
- ➡ Security extensions (data poisoning, …)

iRIS

Intelligent Research Infrastructure Sustainability

2.2

Call	HORIZON-INFRA-2025-01-TECH-01
Proposal	#101275935
Duration	50 months
Coordinator	CERN (Johannes Gutelber)
Funding	~ 5 M€
Status	Préparation du Grant Agreement
Kick-off	**November 1st 2026**

iRIS: AI for the Environmental Footprint of RI

The problem

The LHC consumes ~ 1.3 TWh/year
The FCC, once built will consume significantly more
GANIL consumes ~ 10 GWh/y

How do we pursue discovery and sustainability, from design to operation ?

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How do we pursue discovery and sustainability, from design to operation ?

Four pilot studies

Green Beams

Sustainability from design to operation
Real-time energy audit

Smart Cycle

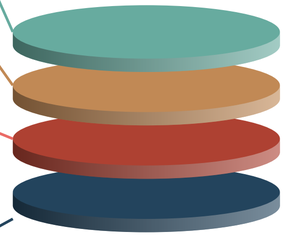
construction material reuse

OpenSkyLab

Ecological impact monitoring

Harmonized Sustainability Assessment

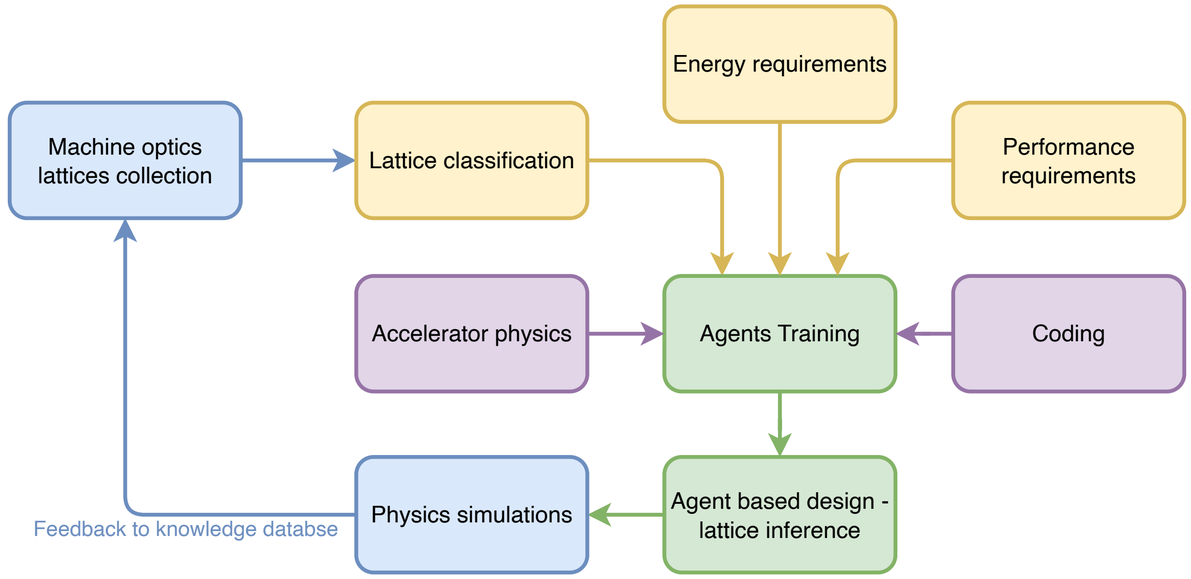
Advanced and harmonized life cycle assessment



iRIS: Four Concrete Technology Pilots

(1) Smart agentic design

Energy driven
FCC use case



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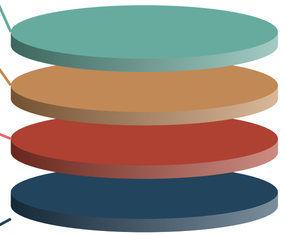

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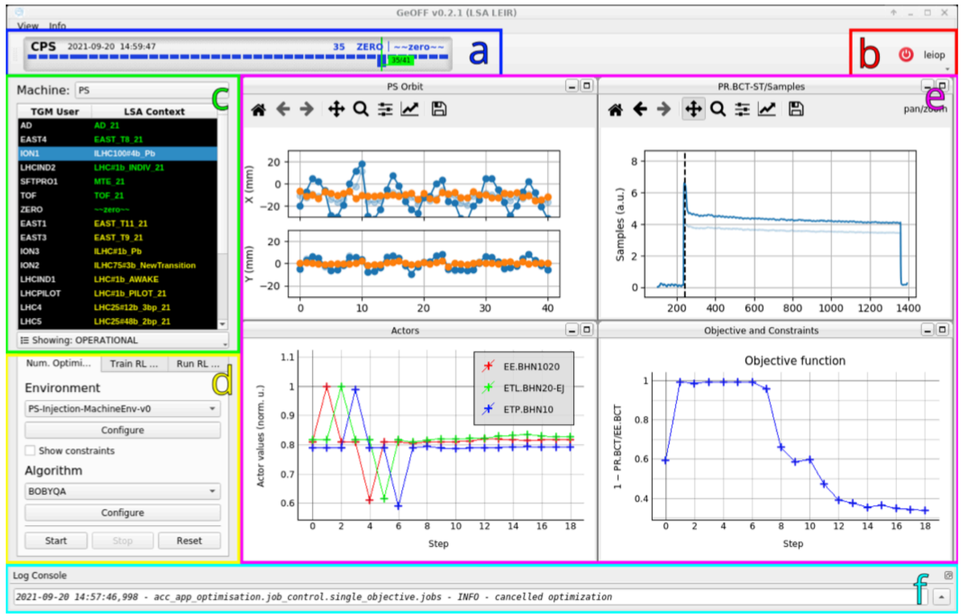
FCC use case

(2) **Tuning in operation**
BO and Reinforcement learning
CIME use case

Four pilot studies



GEOFF optimisation API [Credit : Penny Madisa]
github.xom/geoff-project/coi

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(1) **Smart agentic design**
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FCC use case

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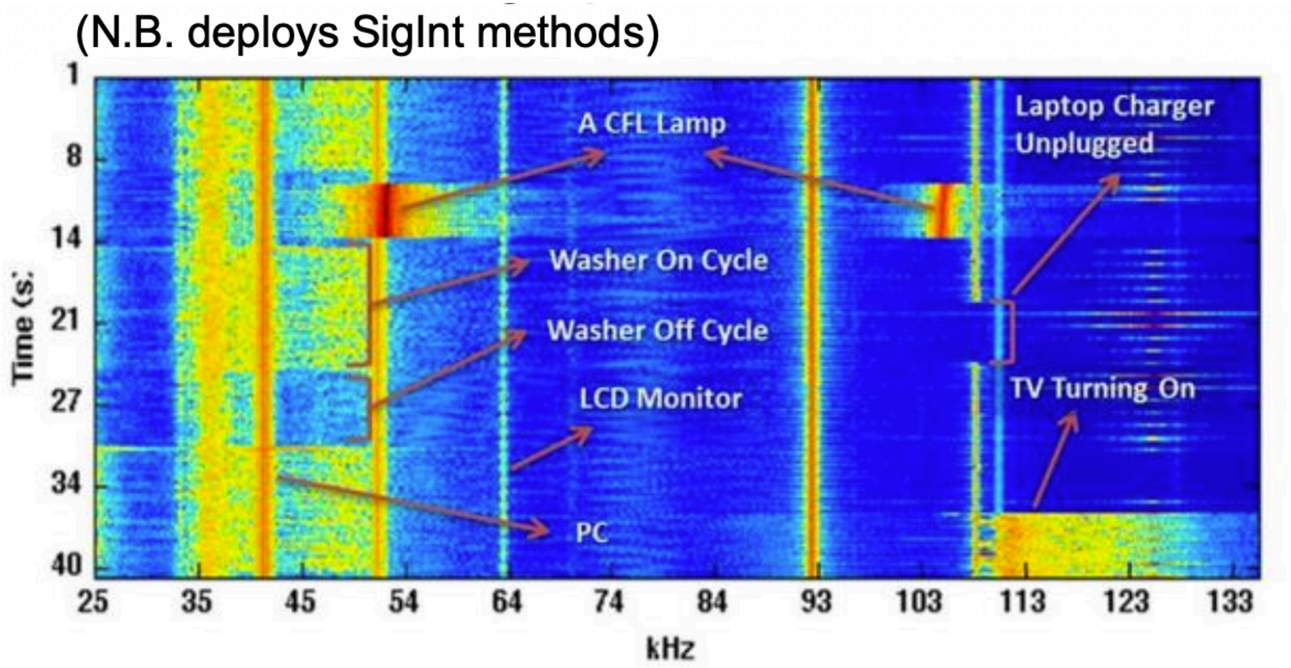
BO and Reinforcement learning
CIME use case

(3) **Non Intrusive Load Monitoring**
Single feeder real-time energy maps
AI identification and drift prediction

Four pilot studies



EMI finger prints example - The GREMLIN project @ IRIS - Credit [R. Steinhagen]

Green Beams

Sustainability from design to operation
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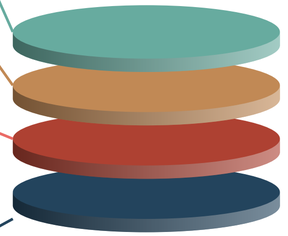


iRIS: Four Concrete Technology Pilots

SmartCycle: Construction Material Reuse

Four pilot studies

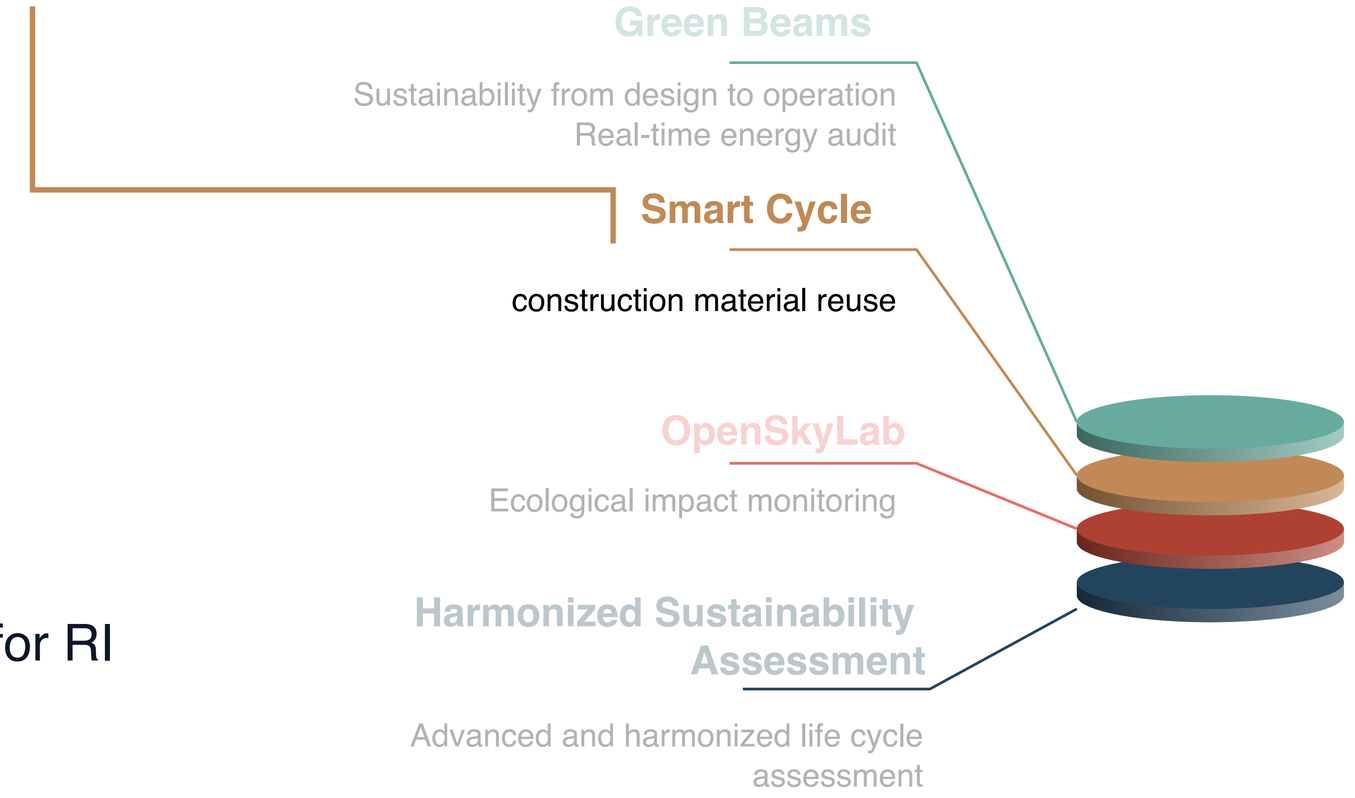
Problem

FCC excavation ≈ **10 million tons** of rock and soil — mostly sent to landfill today.

Approach

- Real-time AI classification of excavation material
- (geology, contamination, structural suitability)
- On-conveyor sensor fusion: hyperspectral + X-ray +
- RGB Circular economy decision support: reuse vs.
- landfill vs. upcycle
- Heritage from EuroCircol & FCCIS projects

Goal: >50% reduction in construction waste for RI projects



iRIS: Four Concrete Technology Pilots

OpenSkyLab: Ecological Impact Monitoring

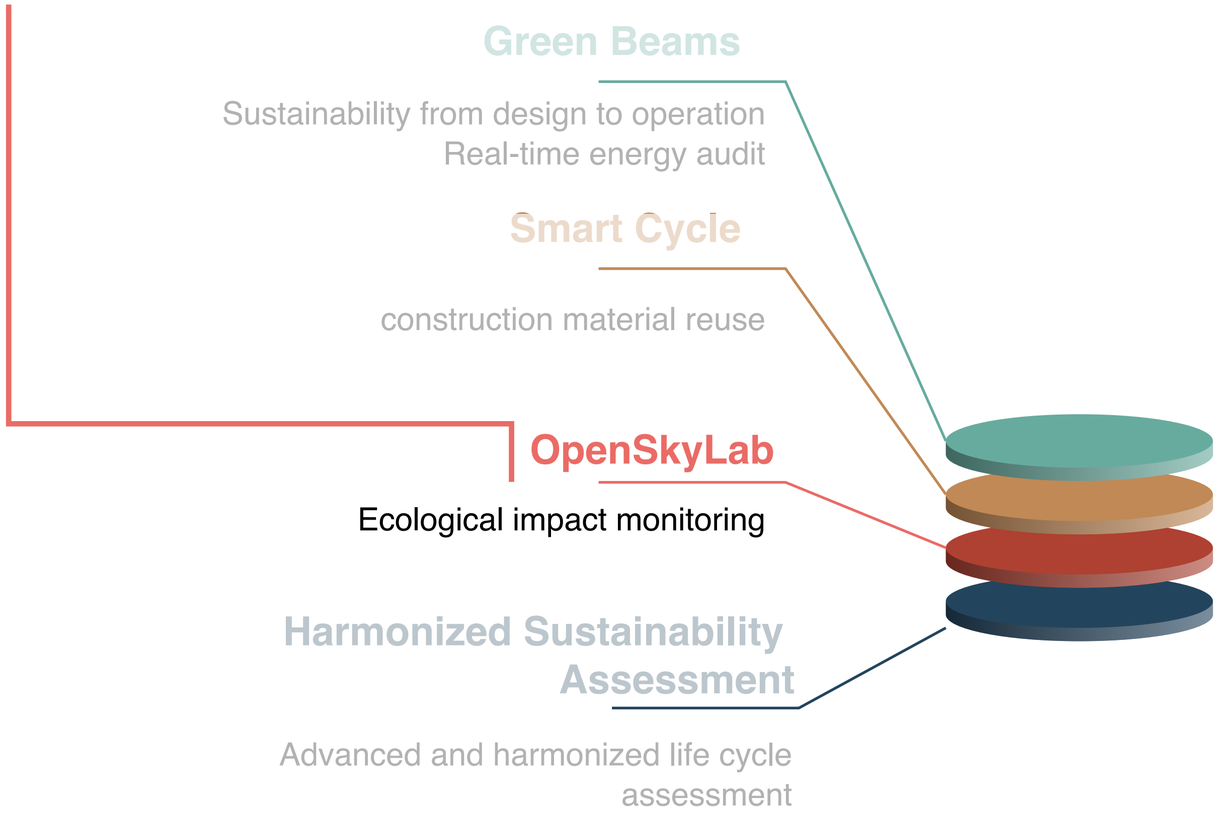
Four pilot studies

Problem

Research infrastructures occupy large land areas and are obligated under EU environmental law to monitor and mitigate ecological impact on surrounding ecosystems.

Approach

- Multi-source sensor fusion: satellite (Sentinel-2), drone
- surveys, ground IoT sensors
- AI models for land-cover classification, biodiversity proxy
- estimation, soil moisture mapping
- Open data platform — long-term longitudinal monitoring
- Linked to EU Biodiversity Strategy 2030



iRIS: Four Concrete Technology Pilots

Harmonised Sustainability Assessment

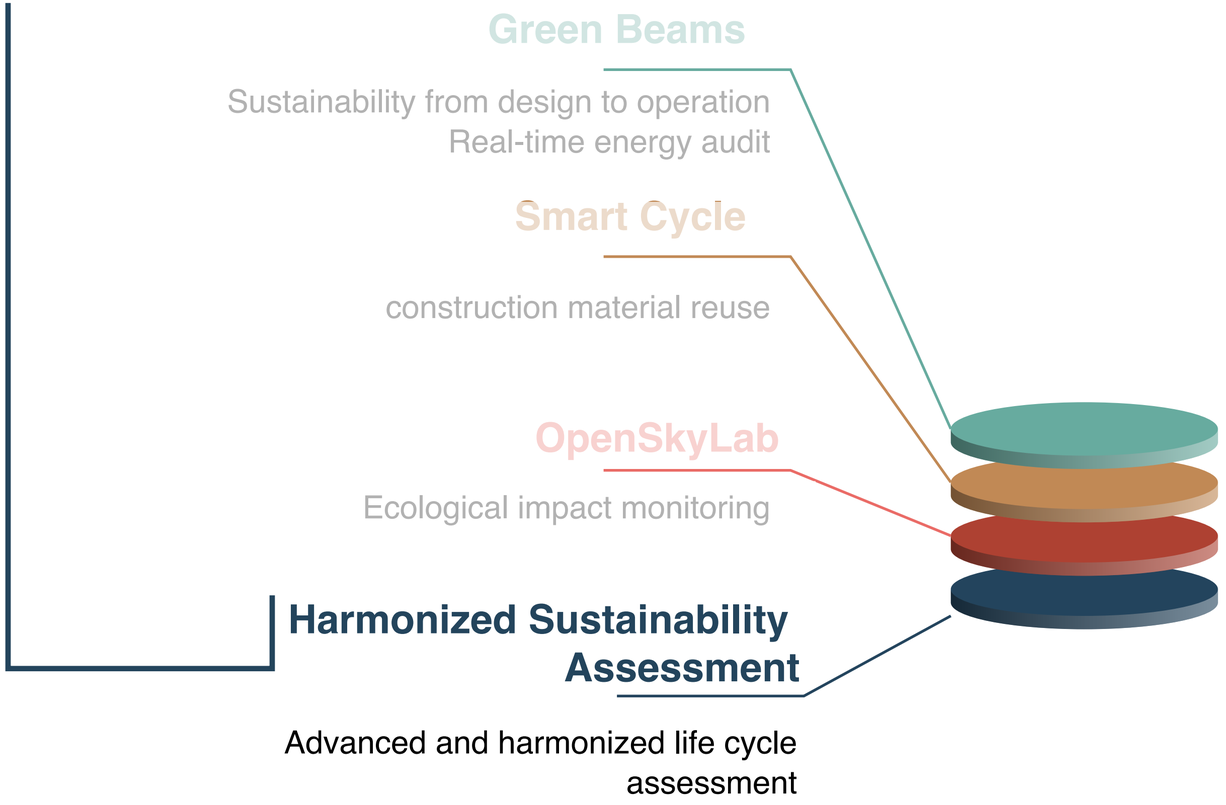
Four pilot studies

Problem

No common methodology exists across European RIs to measure, report, and compare their environmental footprint.

Approach

- Advanced Lifecycle Analysis (LCA) framework tailored to research infrastructure specifics Standardised socio-economic impact evaluation (jobs, regional GDP, skills, knowledge transfer)
- Applicable across all 170 ESFRI landmarks
- Integration with EU Green Deal reporting obligations and Energy Efficiency Directive (EED)
- Open-source LCA toolchain for RI community



SCIANCE

2.3

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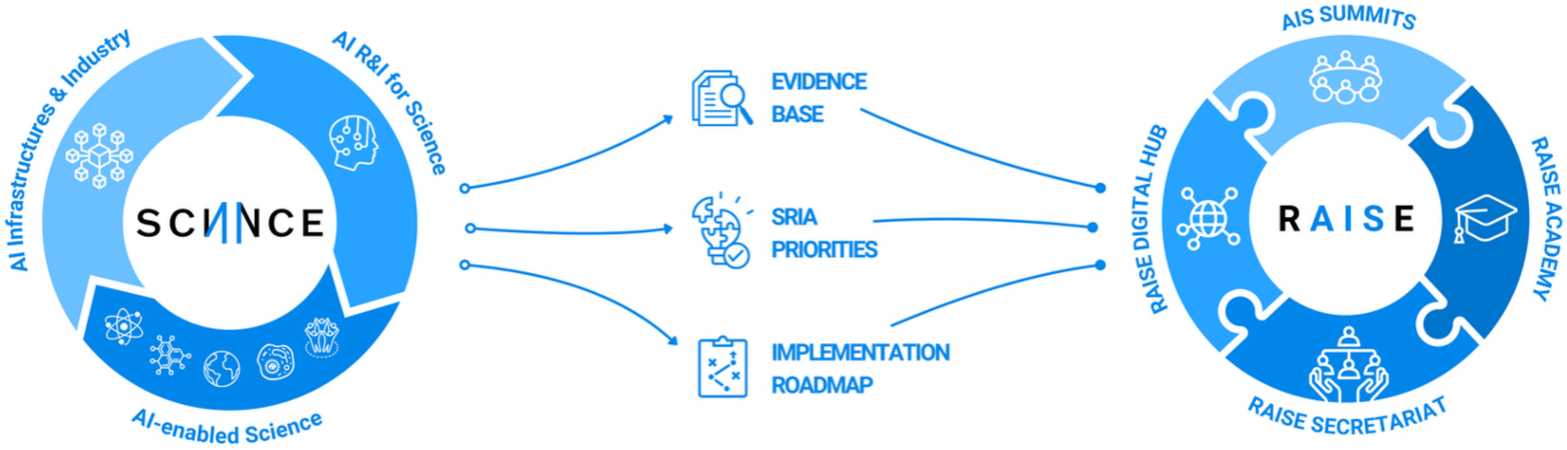
Kick-off	**December 2025**

SCIENCE



Mapping the European AI in Science Landscape

Consolidate evidence on AI use in and for scientific research in Europe, across five pilot scientific domains (and cross-disciplinary AI innovations)

- Astronomy & Physics
- Materials science
- Earth Sciences
- Life Sciences
- Social Sciences & Humanities

Strategic Research & Innovation Priorities

Co-creation workshops and consultations to identify:

- Long-term AI-enabled research priorities in the scientific pilot areas
- AI for science research and innovations priorities
- Interdisciplinary cooperation priorities in AI-driven research

Roadmap for R&I Infrastructure upgrades

- Identify gaps in computing, data access, governance, and skills for AI-enabled science
- Co-design upgrade scenarios and cooperation mechanisms
- Evaluate their feasibility and develop a roadmap aligned with EU strategic initiatives

RAISE Pilot **& Sustainability**

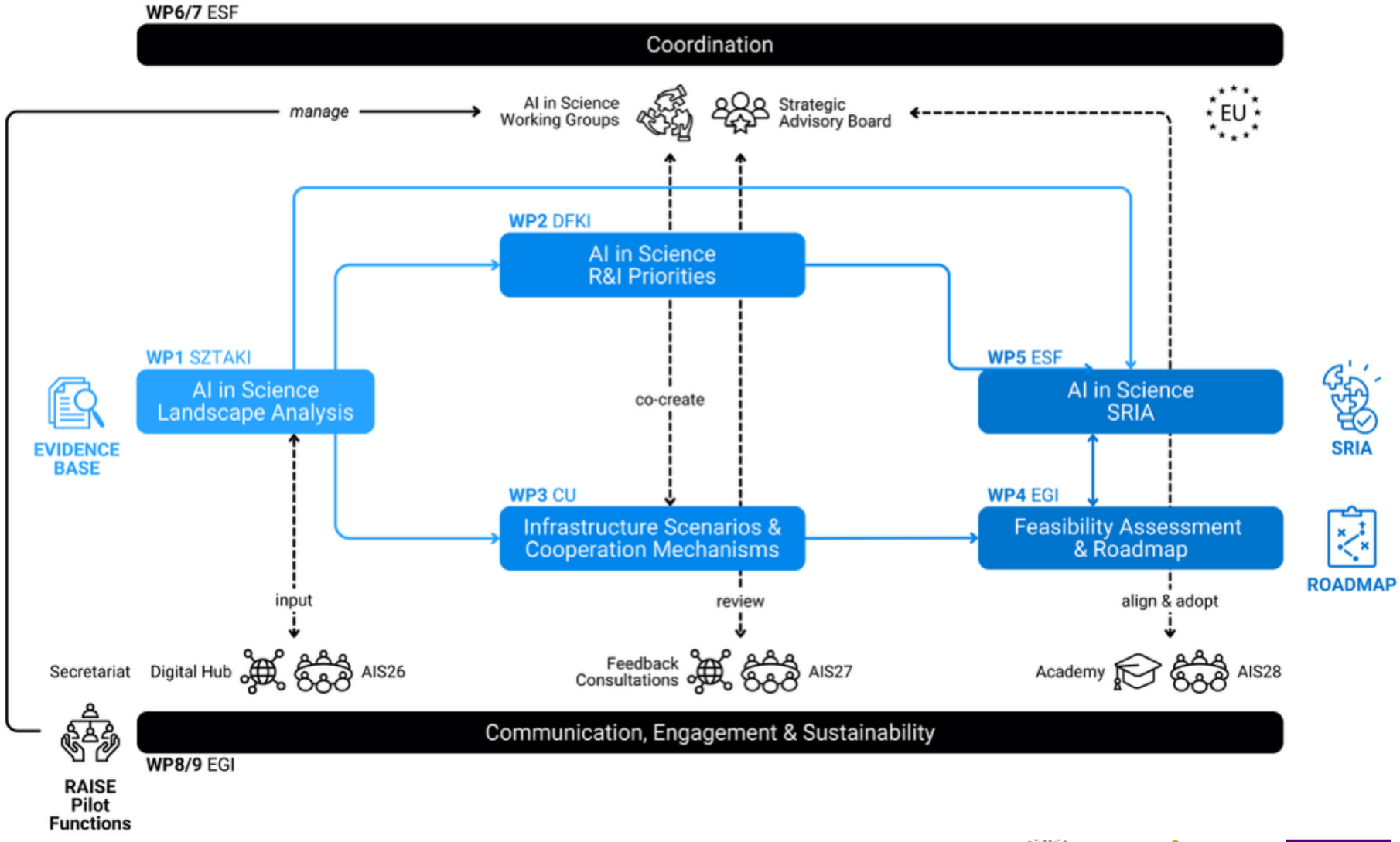
- Build and sustain the AI in Science community by supporting the EC Resource for AI in Science in Europe (RAISE)
- Pilot the RAISE Secretariat, Digital Hub and Academy

SCIANCE

PHASE 1
Consolidation of Knowledge

PHASE 2
Co-creation of R&I priotirites & Infrastructures Scenarios

PHASE 3
Strategic Consolidation & Implementation

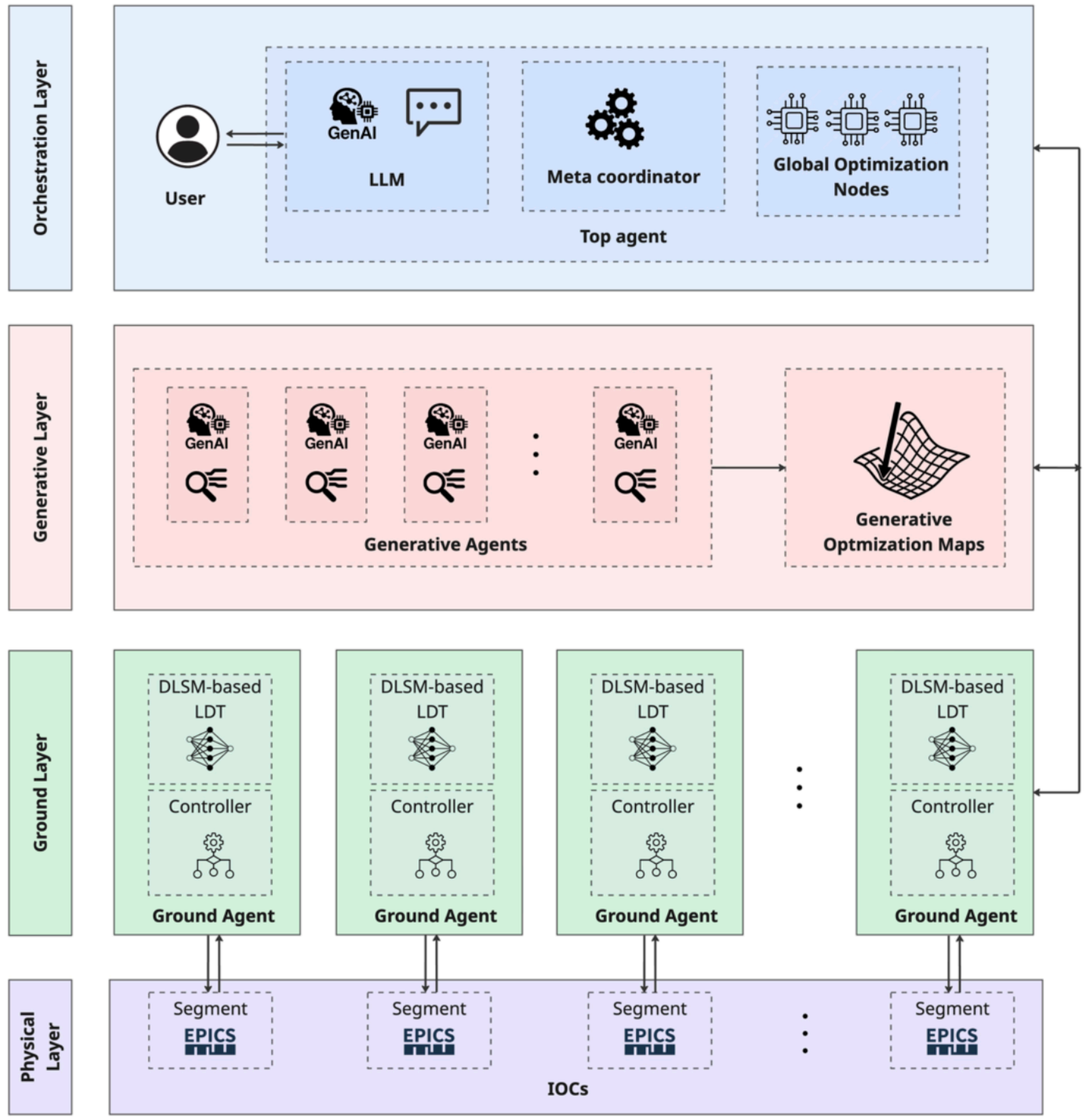


Projects in preparation

3

Projects in preparation this year

- ARTIFACT Doctoral Network
- MODULARITY : bridging particle accelerators and robotics
- COST Actions



MODULARITY — Modular AI for Complex Systems · H. Guler (IJCLab/CNRS)

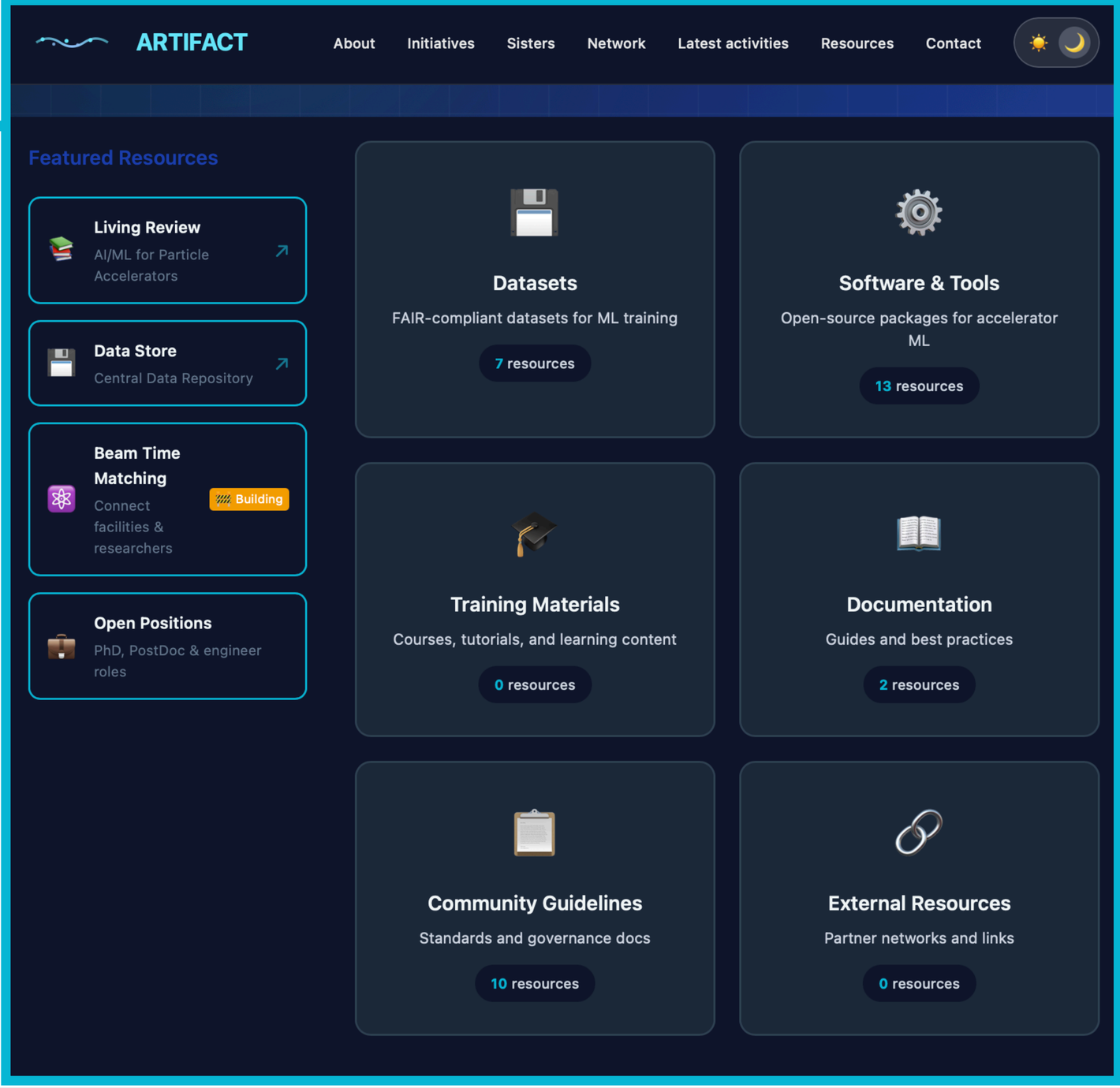
ARTIFACT Resources

4

Resources sharing

A Plaform that connects projects and communities https://artifact-network.org

- Living review
- **Datasets**
- **Data Store & Features store**
- **Open tools catalogues**
- Training materials
- Computing resources
- **Cross-facility beam-time proposals**
- Check out ressources portal user guide
  https://artifact-network.org/resources/documentation/artifact-website-guide/



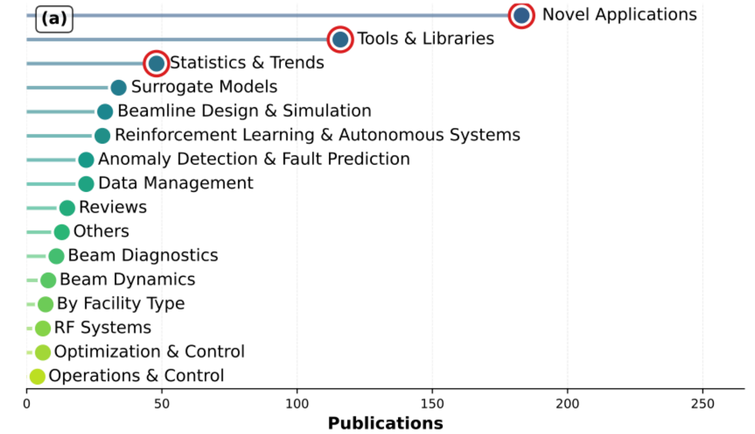
The accelerator ML living review

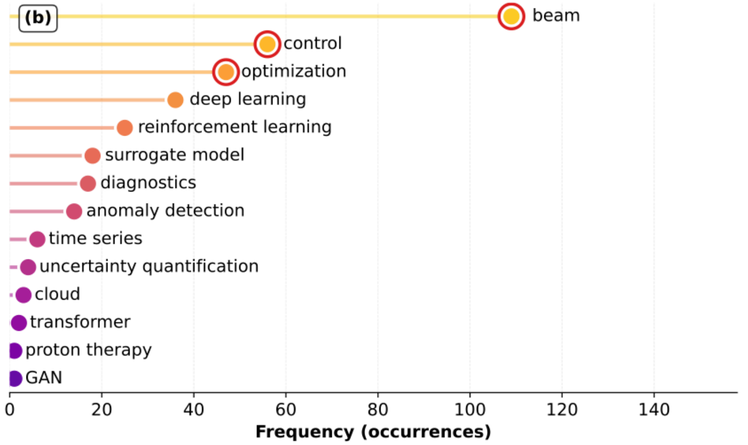
The problem : hundreds of papers uploaded every month across arXiv, Inspire, HAL, openAlex, … ⇢ Static reviews are outdated within months.

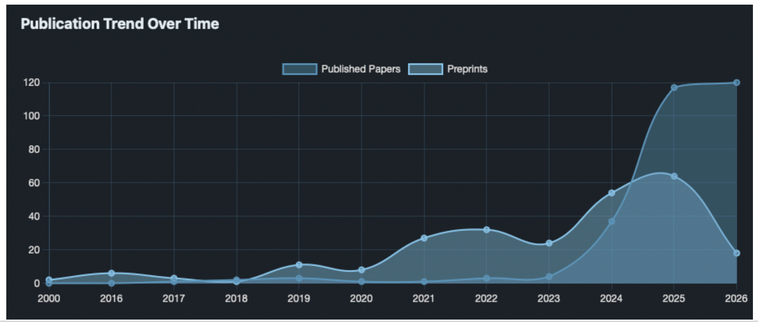
Our solution An automated FAIR-compliant

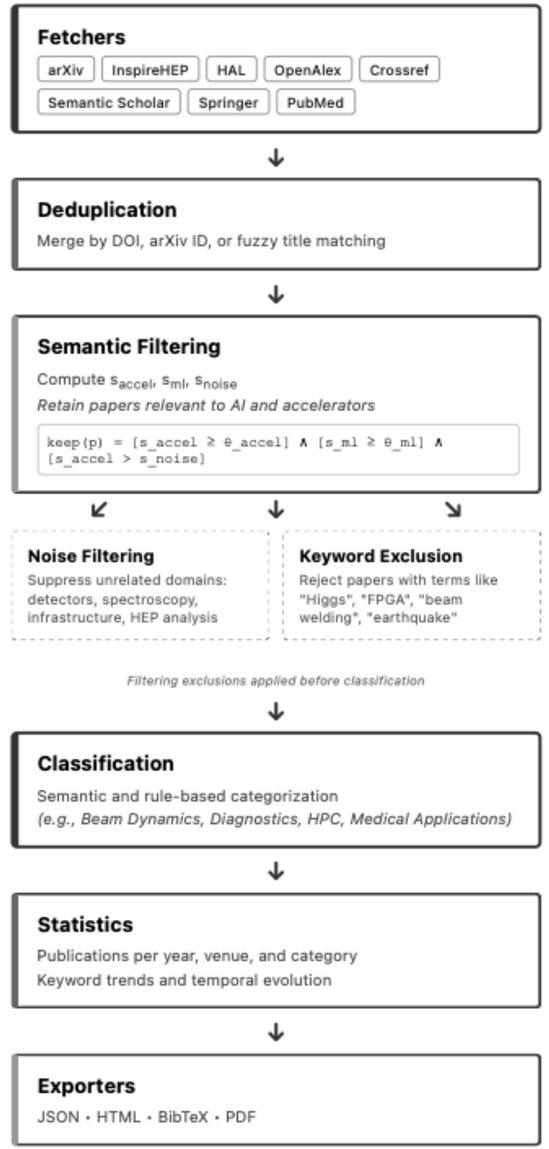
1. Harvest from 5 bibliographic sources
2. Deduplicate by DOI / arXiv ID / fuzzy title
3. Semantic filter via sentence-transformer embeddings → retains~2% of raw harvest
4. Classify into thematic categories
5. Export JSON / HTML / BibT E X / PDF — updated weekly

aghribi.github.io/acc-ml-living-review



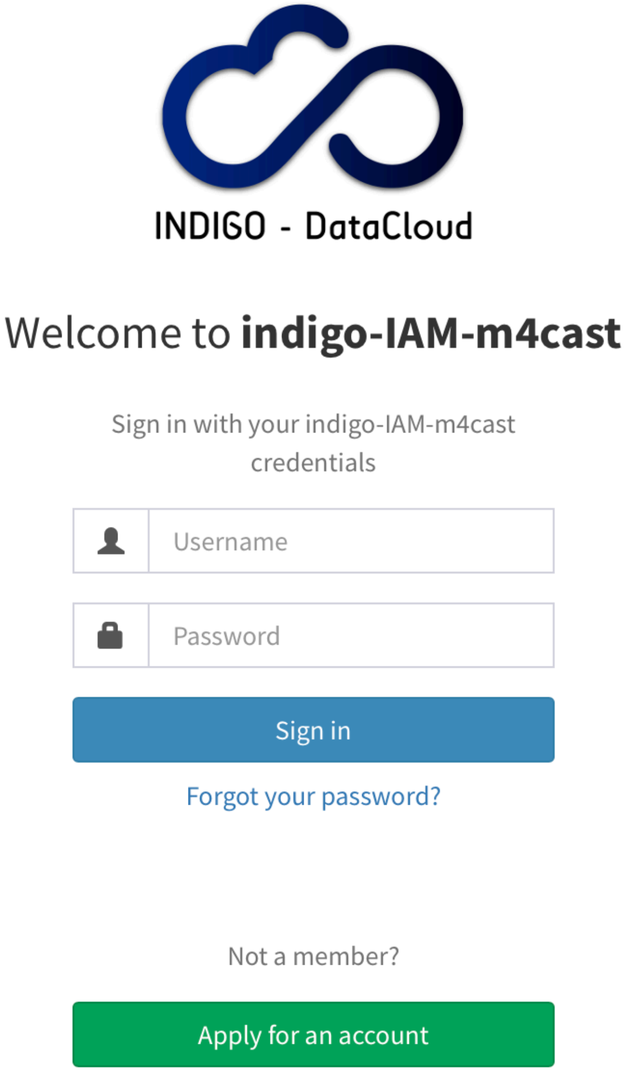






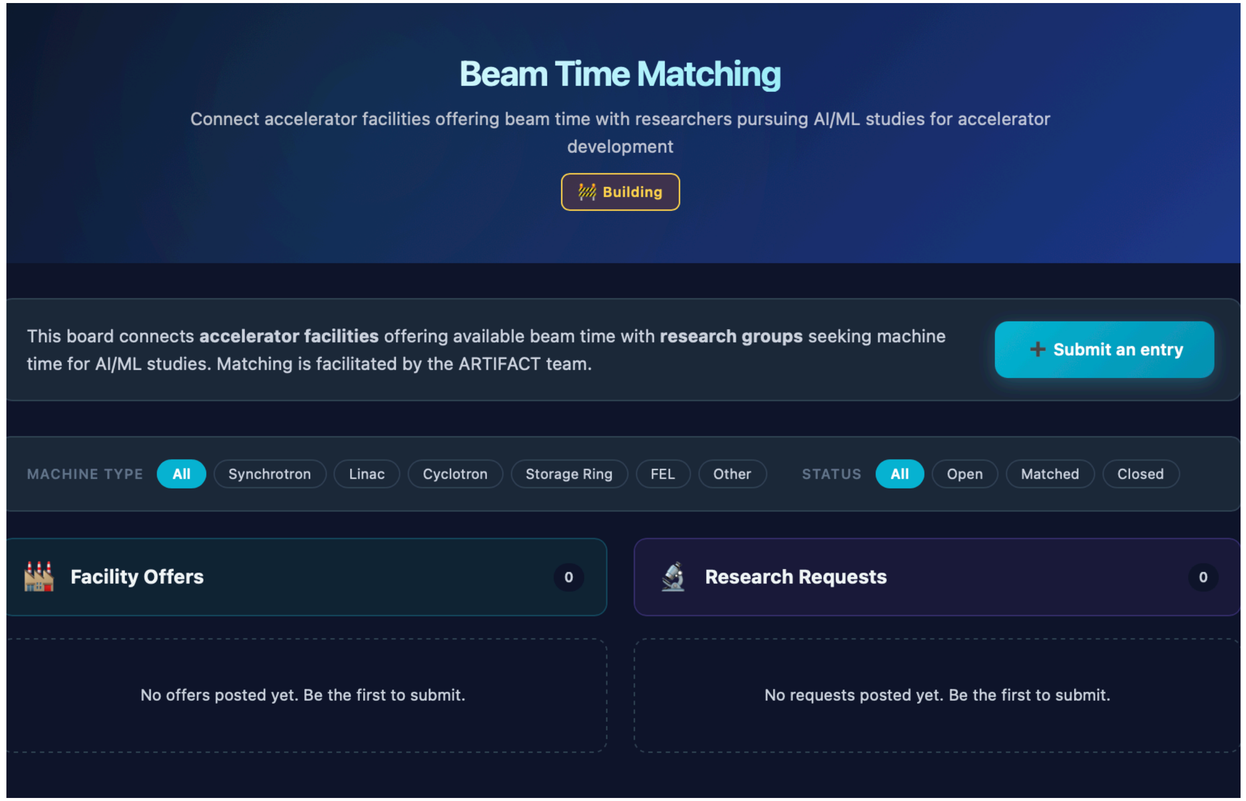
Data Store

- Indigo IAM data store accessible to the community
- Everyone can ask for an account
- Linked feature store coming soon
- Datastore user guide accessible here https://artifact-network.org/resources/documentation/indigo-data-store/



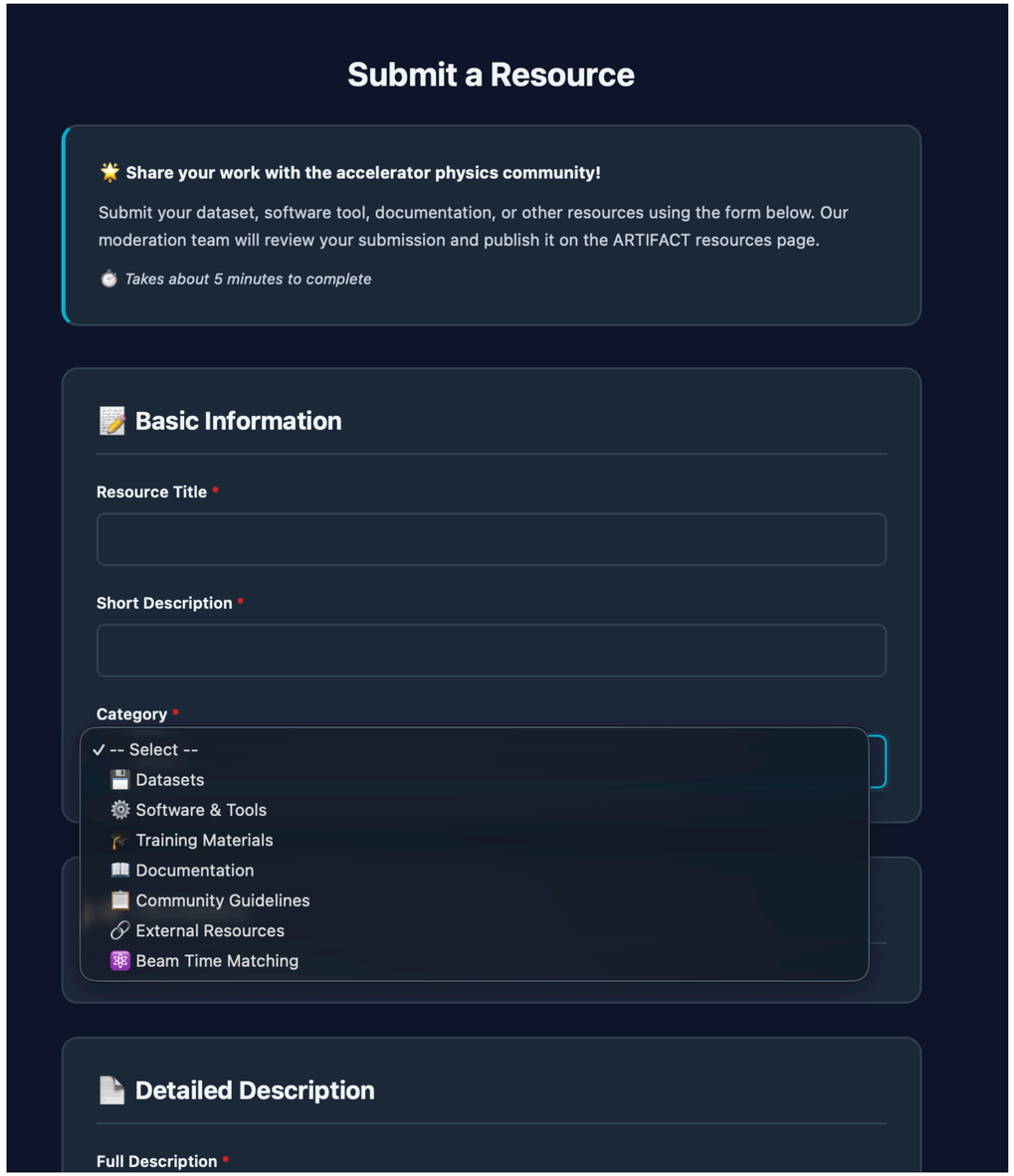
Beam-time matching

- New beam time matching section
  - Facilities propose beam-time
  - Researchers/engineers request
  - We match them
- Incoming infra-serf preparation



Ressources submission

- Everyone can submit resources
- Submissions go through a validation request : automatic branch creation and merge request
- Once merge request approved, entries are automatically integrated
- Links to heavy resources as well as associated DOI and other metadata can of course be added



Discussion

Now, your turn

ARTIFACT

Backup

Shared resources