

Building FAIR Metadata Mapping for Scientific Instruments in URIS

Supporting Recovery and Interoperability
of Research Infrastructures

Postdoc – Philipp Schwartz Initiative
Open Science Lab (TIB)

Dr Sabina Auhunas

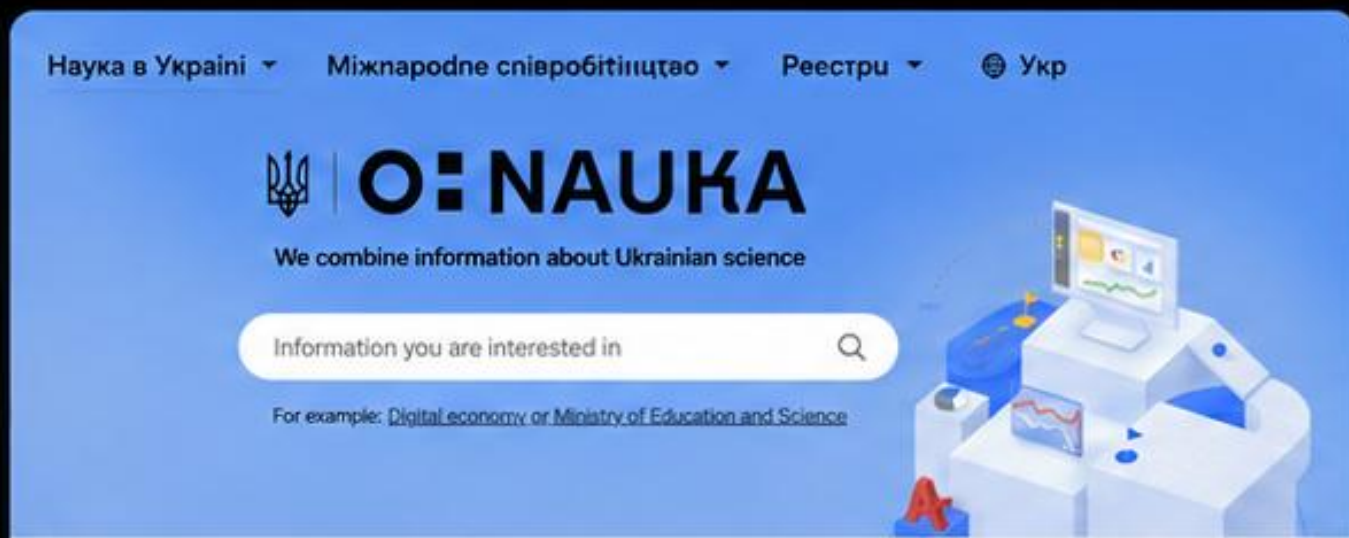
✉ sabina.auhunas@tib.eu

📅 CRIS2026, Portugal | May 20–22, 2026



URIS: The Ukrainian National CRIS Ecosystem

A national infrastructure for research information management, visibility and interoperability



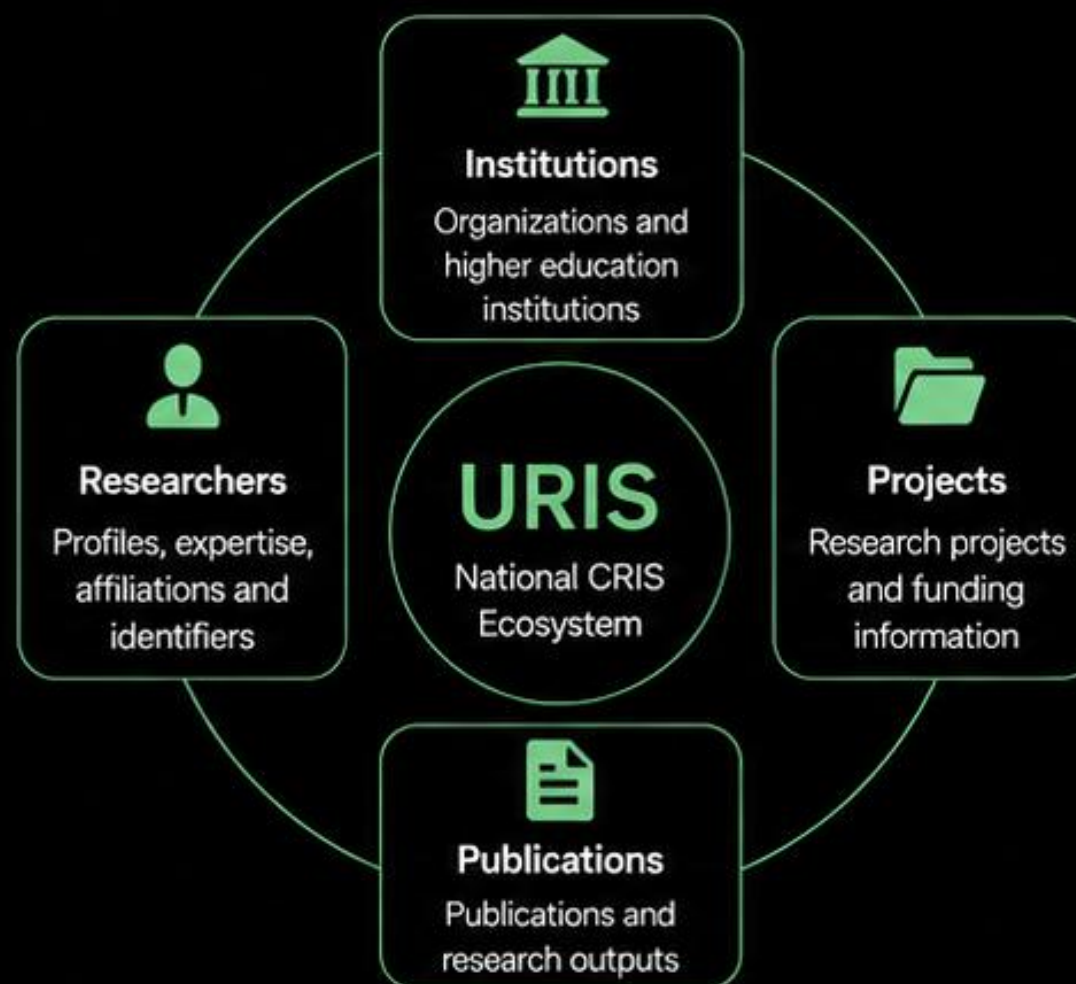
System profiles

Institutions	Researchers	Publications	Projects
Contains information about Ukrainian scientific institutions and institutions of higher education	Contains information about publications, projects, professional activities and other data about Ukrainian scientists	Contains information on publications of Ukrainian scientists imported from ORCID and contributed independently	Contains information on research projects with the participation of Ukrainian scientists, research institutions and free economic zones



URIS (NAUKA) is the national Ukrainian CRIS platform supporting **visibility**, **transparency** and **interoperability** of research information and processes.

CORE ENTITIES ALREADY INTEGRATED IN URIS



URIS integrates key research entities and supports data exchange, interoperability and **alignment with European research information initiatives**.



Scientific Instruments A CRIS Blind Spot

Scientific instruments are not yet sufficiently represented as interoperable metadata entities within URIS.

Current limitations

- ✗ Fragmented inventories across institutions and systems
- ✗ Heterogeneous metadata formats and standards
- ✗ Limited FAIR interoperability
- ✗ Weak or missing PID integration
- ✗ Lack of standardized information on condition, location and access



Integrating scientific instruments into URIS is essential to achieve a **complete, interoperable** and **FAIR** national CRIS ecosystem that supports research and innovation.

Scientific Instruments: A CRIS Blind Spot

Critical research infrastructure remains insufficiently represented in national CRIS

WHY INSTRUMENTS MATTER



Essential for research

Enable scientific discovery and innovation



High-value assets

Significant investment, maintenance and expertise



Shared and mobile

Used across institutions and research communities



Strategic for policy

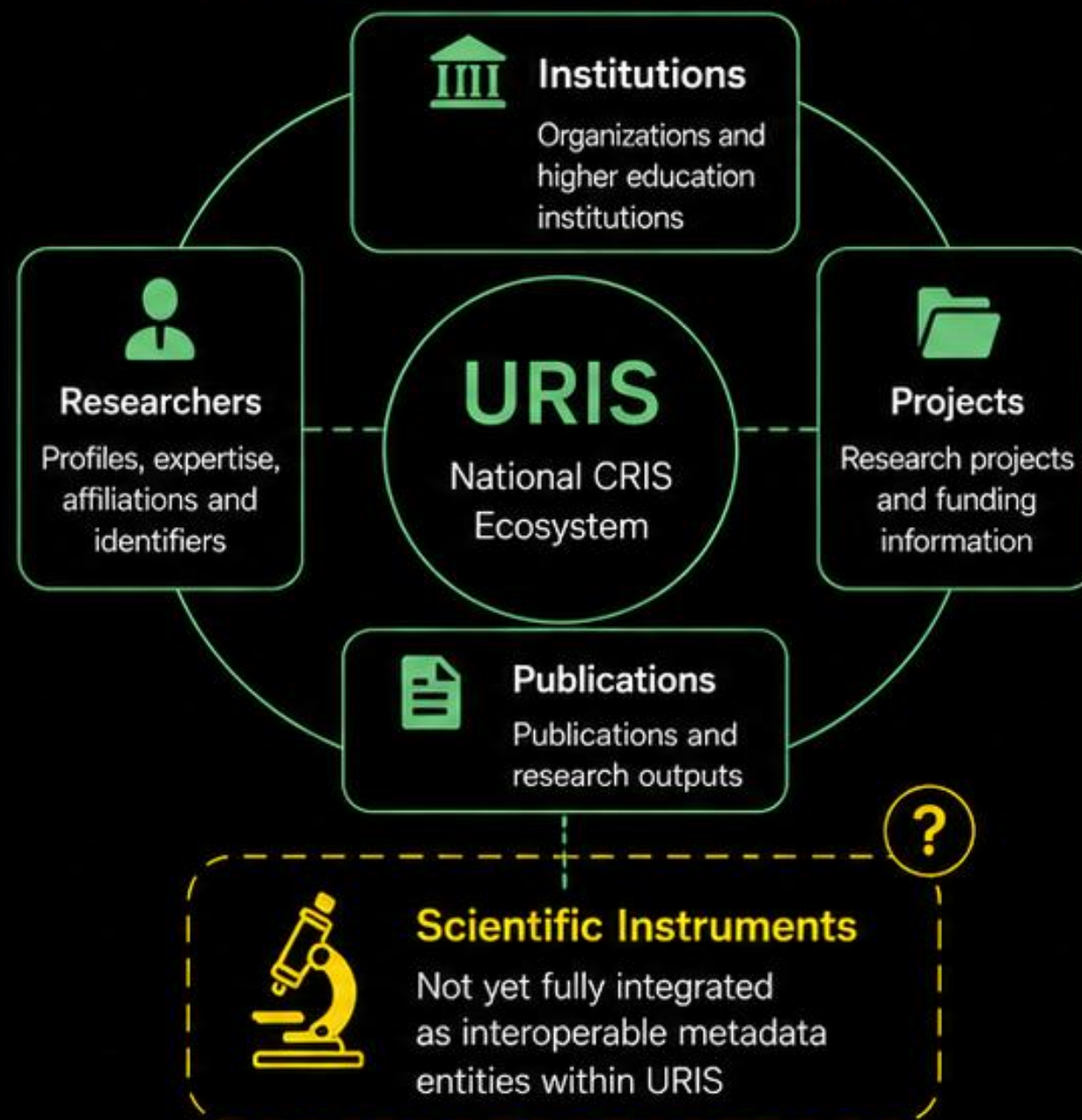
Important for reporting, planning and resource allocation



Vulnerable in crisis

At risk of damage, relocation or loss of functionality

WHERE INSTRUMENTS FIT IN CRIS



KEY INTEGRATION GAPS



Fragmented inventories

Information dispersed across institutions, systems and local spreadsheets



Heterogeneous metadata

Different formats and standards, lack of common data model



Limited FAIR interoperability

Inconsistent identifiers, vocabularies and metadata quality



Weak PID integration

Instruments rarely have persistent identifiers or resolvable records



Missing operational context

Condition, location, access and availability often unknown



As a result: instruments are **hard to find, assess, access and reuse.**



Closing this gap is essential for building a **complete, interoperable** and **FAIR** research information ecosystem in Ukraine and beyond.

Research Infrastructure Landscape in Ukraine

Scientific centres, national heritage facilities and disrupted infrastructure regions



The map reflects the distribution of research infrastructure, national heritage facilities and areas where infrastructure has been **disrupted** or **relocated** since 2022. Instrument-level metadata visibility remains fragmented and incomplete.

LEGEND

- Regional scientific centres / infrastructure hubs
- Disrupted infrastructure regions
- Scientific facilities classified as national heritage
- URIS coordination and aggregation layer
- Relocation and redistribution of research infrastructure

KEY FACTS

- 35%** research infrastructure disrupted or damaged
- 63** shared equipment centres lost or inaccessible
- 147** scientific facilities classified as national heritage
- No harmonized national instrument registry
- Distributed and heterogeneous metadata practices

Metadata Fragmentation and Governance Gaps

Research infrastructure metadata in Ukraine is distributed, inconsistent and not machine-interoperable

SOURCES OF INSTRUMENT AND INFRASTRUCTURE METADATA

Local inventories



- Departmental lists
- Laboratory registers
- Ad-hoc records

Spreadsheets and files



- Excel / Google Sheets
- Different templates
- No version control

Documents and reports



- Word / PDF reports
- Project documentation
- Static snapshots

Websites and pages



- Institutional websites
- Project pages
- Unstructured content

Unstructured communication



- Emails
- Messengers
- Personal notes



Multiple parallel sources • Different formats • Inconsistent content • No synchronization
No unified data model • No persistent identifiers • No machine-readable structure

KEY PROBLEMS



Heterogeneous formats
Different structures and vocabularies across institutions



Lack of harmonization
No common metadata standards or controlled vocabularies



No update cycles
Metadata is not regularly reviewed or synchronized



No persistent identifiers
Instruments, institutions and projects lack stable digital identifiers



Weak interoperability
Data cannot be integrated, shared or reused across systems



As a Result

Research infrastructure remains poorly visible, hard to discover, difficult to manage and impossible to analyze at national level.

- ✗ Limited visibility of instruments and capabilities
- ✗ Inefficient use of resources
- ✗ Barriers to collaboration and data sharing
- ✗ Challenges for reporting and decision-making
- ✗ Reduced readiness for recovery and resilience planning



Fragmented and inconsistent metadata practices prevent Ukraine from building a **complete, interoperable** and **FAIR** research infrastructure ecosystem.

Project Overview

Building a FAIR Metadata Mapping Model for Scientific Instruments in URIS

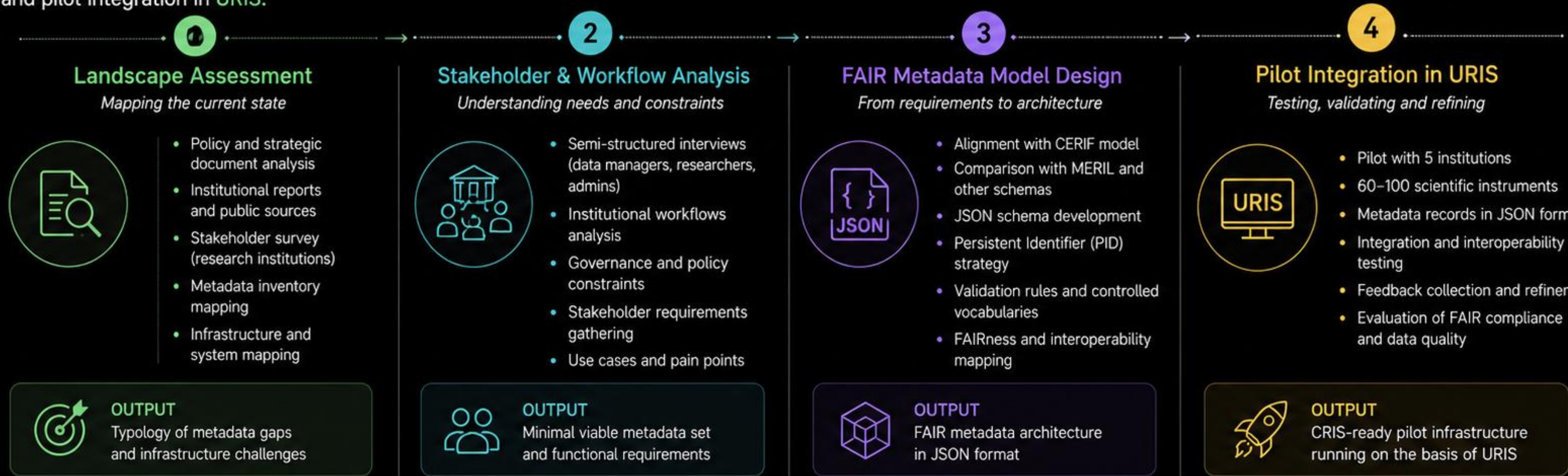
This project aims to develop and pilot a **FAIR-compliant, CRIS-integrated** metadata model for scientific instruments in Ukraine and enhance interoperability within **URIS**.



The project will contribute to building a **FAIR, interoperable** and **resilient** research infrastructure ecosystem in Ukraine, aligning with European and global best practices in research information management.

Research Design and Implementation Workflow

A phased approach from ecosystem assessment to FAIR metadata model development and pilot integration in URIS.



Existing Infrastructure Module in URIS: Foundation for Extension

From infrastructure registry to FAIR, instrument-level metadata



Existing Functionality

- Infrastructure discovery and search
- Institutional visibility and representation
- Equipment and infrastructure registration
- Infrastructure categories and basic metadata



Current Limitations

- Limited instrument-level granularity
- Weak FAIR interoperability
- Missing machine-readable structure
- No standardized PID strategy
- Limited metadata harmonization
- Insufficient for CRIS integration



Project Contribution

The project extends the current URIS infrastructure module toward:

- FAIR metadata architecture
- JSON-based interoperability
- PID-enabled integration
- Machine-readable instrument records



URIS provides a strong foundation. Our project builds the missing **FAIR, machine-readable layer** for scientific instruments.



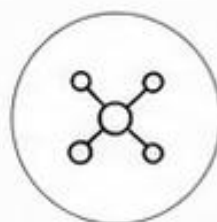
Infrastructure Registry

Current URIS module
Discovery, basic metadata,
institutional visibility



FAIR Metadata Layer

Project extension
JSON schema, PID, harmonized
and machine-readable metadata

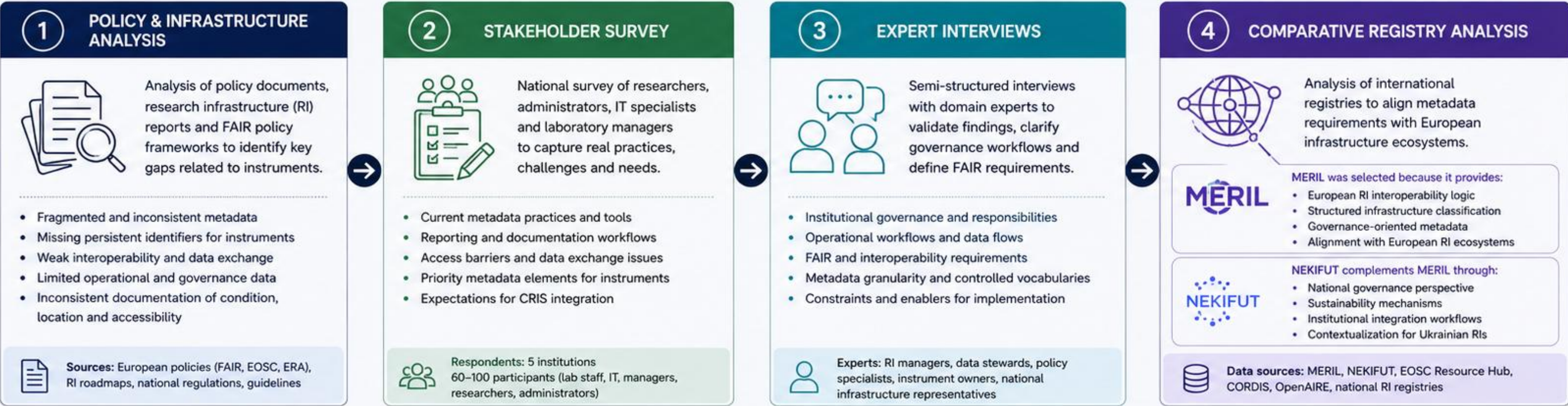


CRIS-Integrated Instrument Ecosystem

Interoperable, resilient
and data-driven research
infrastructure

From Policy Gaps to Metadata Requirements

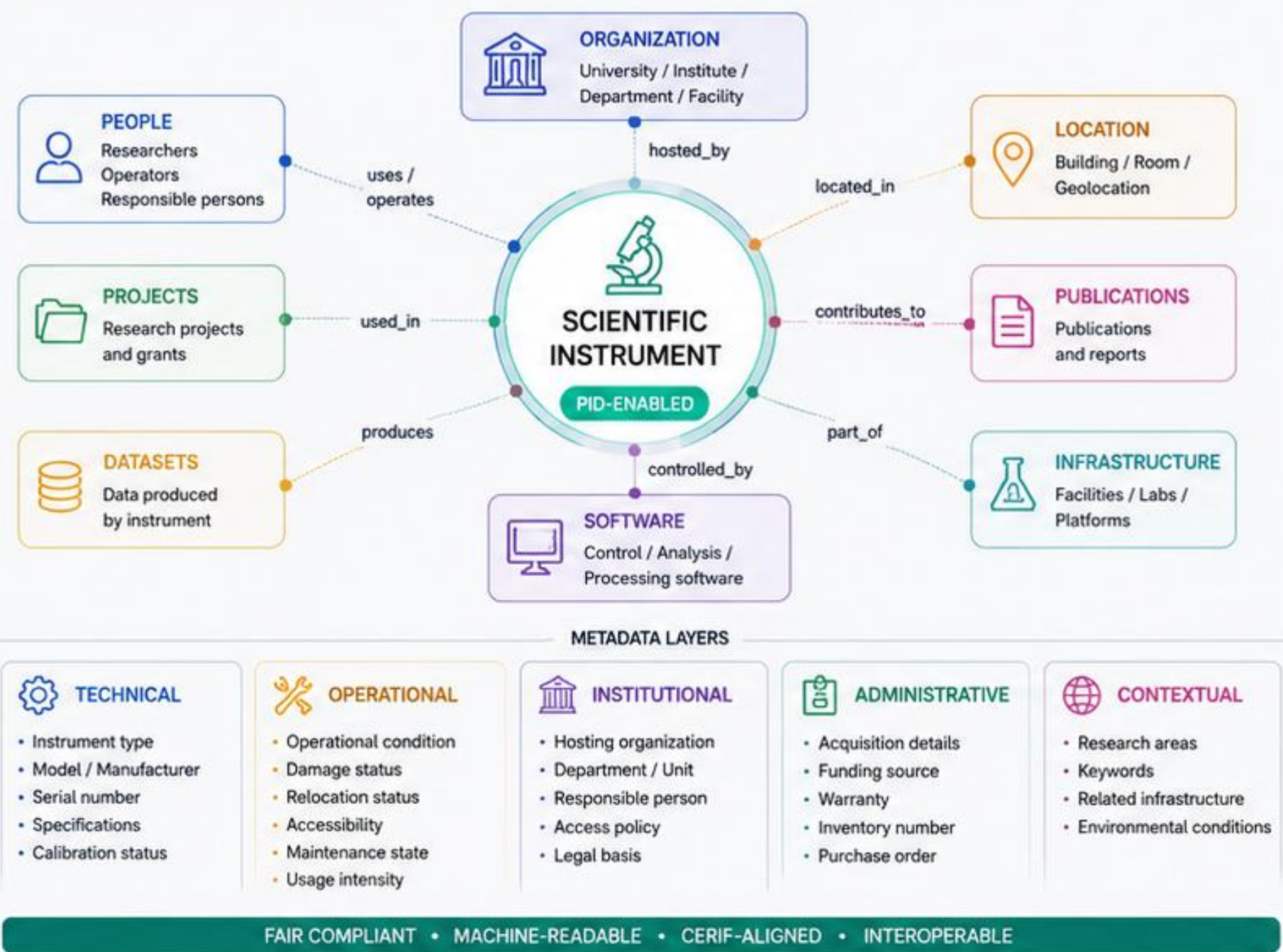
A multi-stage, evidence-based approach to define FAIR metadata for scientific instruments in CRIS ecosystems



Scientific Instrument Metadata Architecture

Interconnected. FAIR. Machine-readable. CRIS-integrated.

The metadata model represents scientific instruments as central research entities connected to people, organizations, projects, outputs and infrastructure.



JSON EXAMPLE: SCIENTIFIC INSTRUMENT RECORD

```
{
  "@context": "https://uris.org/schema/instrument/v1",
  "@type": "ScientificInstrument",
  "id": "https://uris.org/instruments/inst-00012345",
  "pid": {
    "type": "Handle", "value": "20.5000/uris.inst.00012345",
    "url": "https://hdl.handle.net/20.5000/uris.inst.00012345"
  },
  "identifier": {
    "internalId": "INST-00012345",
    "barcode": "URIS-I0P-00012345",
    "qrCode": "https://uris.org/instruments/inst-00012345/qr"
  },
  "title": "Confocal Laser Scanning Microscope LSM 880",
  "instrumentType": "Microscope",
  "manufacturer": "Carl Zeiss",
  "model": "LSM 880",
  "serialNumber": "ZEISS-LSM880-123456",
  "yearOfManufacture": 2021,
  "technicalSpecifications": {
    "opticalSystem": "Confocal",
    "laserLines": [ "405nm", "488nm", "555nm", "639nm" ],
    "detectors": [ "PMT", "GaAsP" ],
    "resolution": "200 nm (lateral)",
    "software": "ZEN 3.4"
  },
  // --- see right column for the rest of the record
}
```



OPERATIONAL STATUS

```
"operationalStatus": {
  "operationalCondition": "Fully operational",
  "damageStatus": "No damage",
  "relocationStatus": "On-site",
  "installationDate": "2021-07-01",
  "lastMaintenanceDate": "2025-02-10",
  "nextMaintenanceDate": "2026-02-10",
  "usageIntensity": "High",
  "accessibility": "Internal and external researchers",
  "safetyRequirements": "Eye protection required; Laser safety class 2"
},
```



INSTITUTIONAL CONTEXT

```
"location": {
  "facility": "Laboratory of Molecular Imaging",
  "building": "Building 1",
  "room": "1.25",
  "address": "Leontovycha 9, Kyiv, 01601, Ukraine",
  "coordinates": { "lat": 50.4422, "lng": 30.5411 }
},
"responsiblePerson": {
  "name": "Dr. Olena Kovalenko",
  "email": "o.kovalenko@biochem.kiev.ua",
  "orcid": "0000-0002-1234-5678",
  "phone": "+380 44 234 5678"
},
"ownershipType": "University asset",
"accessPolicy": "Internal and external researchers"
```



RELATIONS & LINKS

```
"linkedEntities": {
  "projects": [ "https://pris.org/projects/prj-00111", "https://pris.org/projects/prj-00034" ],
  "publications": [ "https://uris.org/publications/pub-12345" ],
  "datasets": [ "https://zenodo.org/dol/10.5281/zenodo.1234567" ]
},
```



ADMINISTRATIVE & OTHER

```
"acquisitionDate": "2021-06-15",
"acquiredBy": "Palladin Institute of Biochemistry",
"fundingSource": "State Budget of Ukraine",
"cost": { "amount": 245000.00, "currency": "EUR" }
```



FAIR BY DESIGN

Findable, Accessible, Interoperable, Reusable



MACHINE-READABLE

JSON schema for automatic processing and validation



CRIS INTEGRATION

Aligned with CERIF model and URIS data structures



INTEROPERABLE

RESTful API and standard formats for data exchange



RESILIENT INFRASTRUCTURE

Metadata supports continuity, recovery and risk management

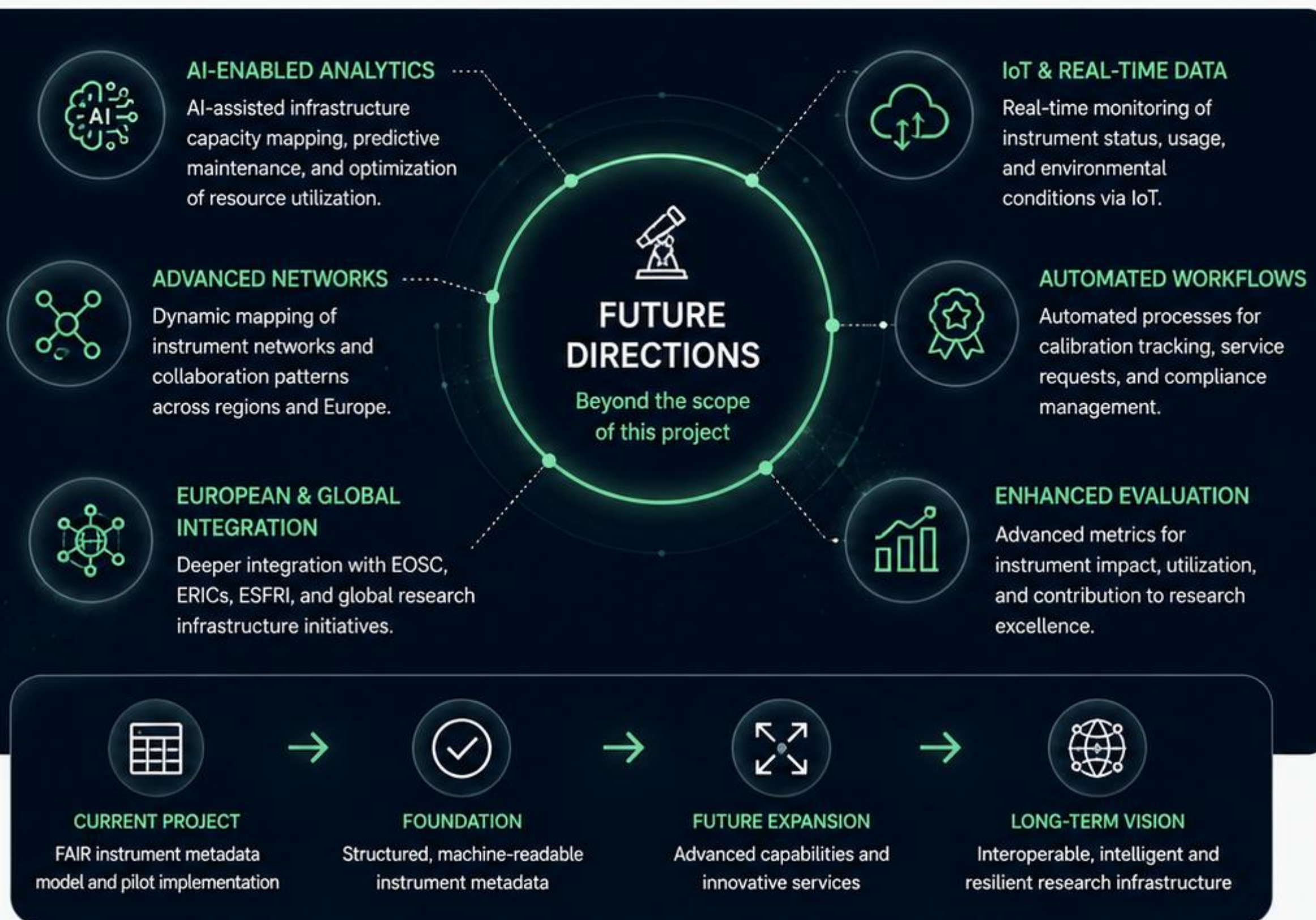


PILOT IMPLEMENTATION

5 institutions
60–100 instruments
URIS platform

Next Steps: Future Directions Beyond the Project Scope

Opportunities for expansion and innovation – not included in the current project implementation



OUT OF SCOPE FOR THE CURRENT PROJECT

The following directions represent future opportunities and innovation areas. They are **not included in the implementation** within this project.



AI-driven predictive models for equipment failure and maintenance scheduling



Real-time IoT integration for continuous data collection and telemetry



Cross-border infrastructure marketplace and resource sharing platform



Automated compliance, certification and auditing workflows



Advanced bibliometric and socio-economic impact analytics



Integration with education, training and citizen science platforms



These future directions require additional development, resources and partnerships beyond the scope of this project.

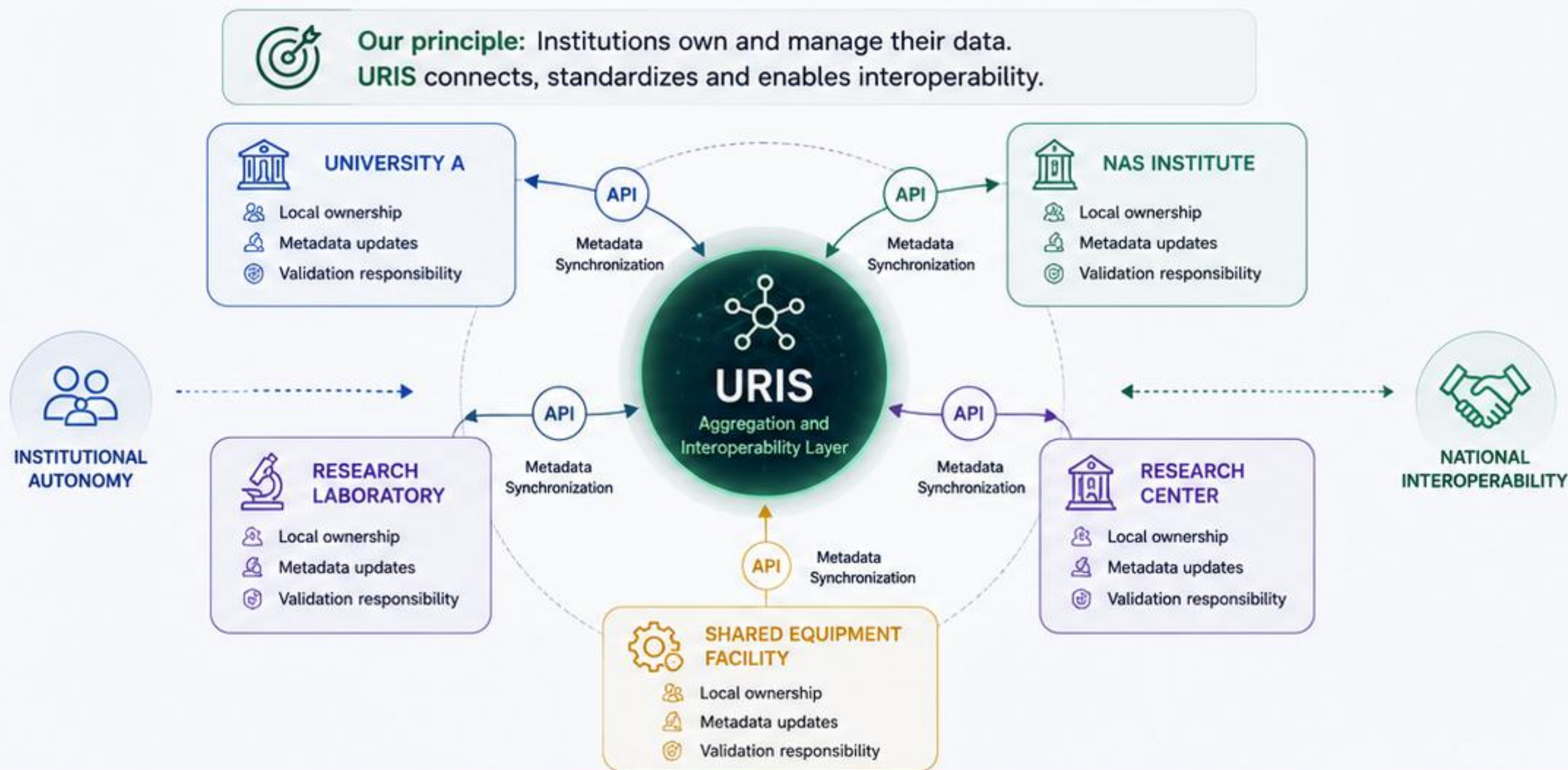


These next steps represent the potential evolution of the model and its ecosystem.

They will be explored in future initiatives.

Governance and Sustainability Model

A federated approach that balances institutional autonomy with national interoperability



GOVERNANCE PRINCIPLES



Federated governance

Decentralized data ownership with central interoperability.



Institutional autonomy

Institutions manage and validate their own instrument metadata.



Shared metadata standards

Common data model and controlled vocabularies ensure consistency.



FAIR alignment

Findable, Accessible, Interoperable, Reusable by design.



Open formats & open APIs

JSON, RESTful APIs and open standards for sustainable integration.



No vendor lock-in

Open-source friendly, technology-agnostic approach.



Machine-readable interoperability

Designed for automated exchange and AI-ready analytics.

SUSTAINABILITY LAYER



JSON

Machine-readable metadata



API

RESTful APIs for data exchange



CERIF

Alignment with CERIF model



PID

Persistent identifiers for instruments



EOSC

Compatibility with EOSC ecosystems



PILOT DEPLOYMENT

- ✓ 5 institutions
- ✓ 60–100 instruments
- ✓ URIS integration environment



Safe testing, iterative improvement and scalable rollout.



This model ensures long-term sustainability, data quality and interoperability, enabling scientific instruments to become first-class CRIS entities.

Conclusions and Strategic Impact

Scientific instruments must become first-class CRIS entities.

1. FAIR interoperability

Structured instrument metadata enables machine-readable interoperability across CRIS and European RI ecosystems.

2. Infrastructure resilience

Ukraine demonstrates why operational infrastructure metadata matters for recovery, continuity and coordination.

3. AI-ready infrastructures

JSON-based metadata and PID integration support analytics, discovery and future AI-enabled infrastructure intelligence.

4. Strategic contribution

The project provides a scalable framework for integrating scientific instruments into national and interoperable CRIS systems.

**From fragmented inventories
to FAIR and interoperable infrastructure ecosystems**

Questions & Discussion

Thank you.



Sabina Auhunas

sabina.auhunas@tib.eu



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