



LEAPS

League of European
Accelerator-based
Photon Sources

The DIGITAL LEAPS Initiative

Michele Svandrik

*Elettra Sincrotrone Trieste
Chair of the LEAPS Research and Development Board*

4-7 October 2022, Granada
Big Science Business Forum 2022

The LEAPS consortium serves an interdisciplinary European user community

LEAPS in figures:

- 19** facilities - **16** institutions - **10** countries
- > **300** operating End-Stations
- > **1.000.000** h beam time /year
- > **5.000** publications/year
- > **15** spin off companies
- > **35.000** user/year from all EU & beyond researchers from all research areas



Associate: SESAME (Jordan)
Partners: ESUO, LENS, CLS

DIGITAL LEAPS

A European Strategy on the Digital Transformation of *Accelerator-based Photon Sources (synchrotrons and free-electron-lasers)* towards a resilient and sustainable European Research Area

Time schedule

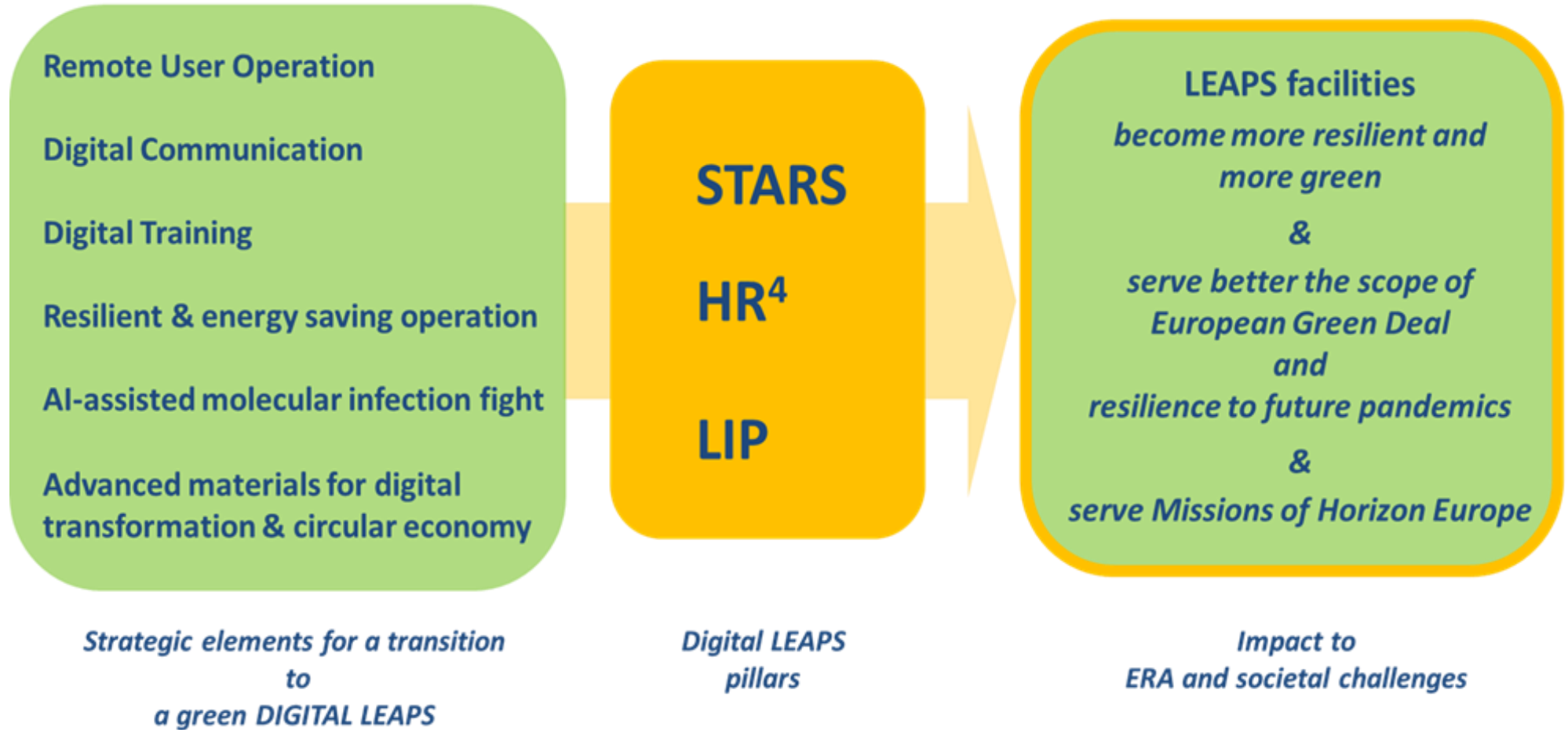
- 2021:** *preparation phase*
- 2022-2023:** *first phase (networking and planning)*
- 2024 onward:** *main implementation*



A Strategic Pathway to a **DIGITAL & Green LEAPS**

DIGITAL LEAPS – Three Pilot Projects/Programs

DIGITAL LEAPS



DIGITAL LEAPS (DL) – First phase (2022-2023)

- **DL 1st** phase focus is on networking activities (*e.g. workshops, platforms, training*).
- Goals of the **DL 1st** phase are:
 - **Provide an overview** of the different actions undergoing at the LEAPS facilities to become more resilient.
 - **Explore opportunities** to create **green facilities** including circular economy aspects and **interactions with industry**.
 - **Foster future common initiatives**, e.g. proposals for HE calls or other RI work programs.
- Reports will be provided at the end of the **DL 1st** phase (*in about 1 year*), including the *proposal for the **main implementation phase (2024+)***.

DIGITAL LEAPS – Outline



1. Photon Source, Transport and Delivery to Experiments

- **LIP:** LEAPS Integrated Platform, to speed up digital interface system to access & operate green.



2. Sample Handling

- **STARS:** Surveying Technology for Advancing Remote Services



3. Remote Interaction with Staff, Users and Stakeholders

- **HR⁴:** Enhance digital platforms for networking & training



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DIGITAL LEAPS: LIP
LEAPS Integrated Platform

Marco Calvi
Paul Scherrer Institute

LIP - Outline

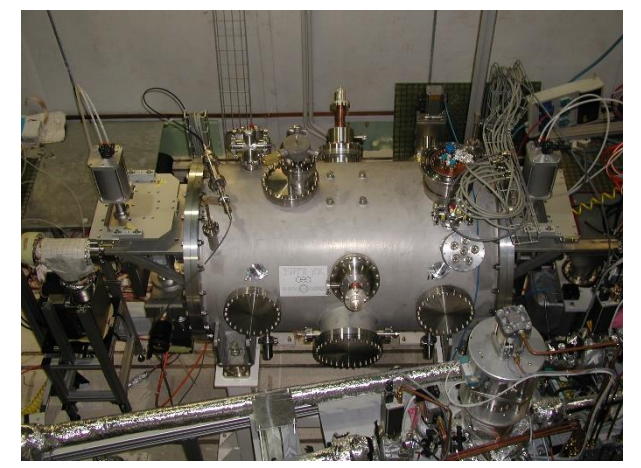
1. DIGITAL Twinning

→ The Technology Platform

| Preparation | Execution | | Analysis |
|---|--|---|--|
| | | | |
| Digital modeling Simulation of experiment Probe beam requirements Instrument configuration Sample design | Digital shadowing Updating model Comparison of observation & prediction Augmented learning | Digital twinning Real-time feedback Optimized parameter selection Automated operation | Digital shadowing Data interpretation Re-evaluation of experiment parameters Processing data |

2. Design activities and networking

- Androids
- Permanent Magnets
- Harmonic Cavities
- Fully Automated Beamline



LIP - Digital Twinning

The Technology Platform

shall enable digital twinning to make preparation, execution and analysis of the experiments more effective leading to higher success rates.

| Preparation | Execution | | Analysis |
|---|---|--|---|
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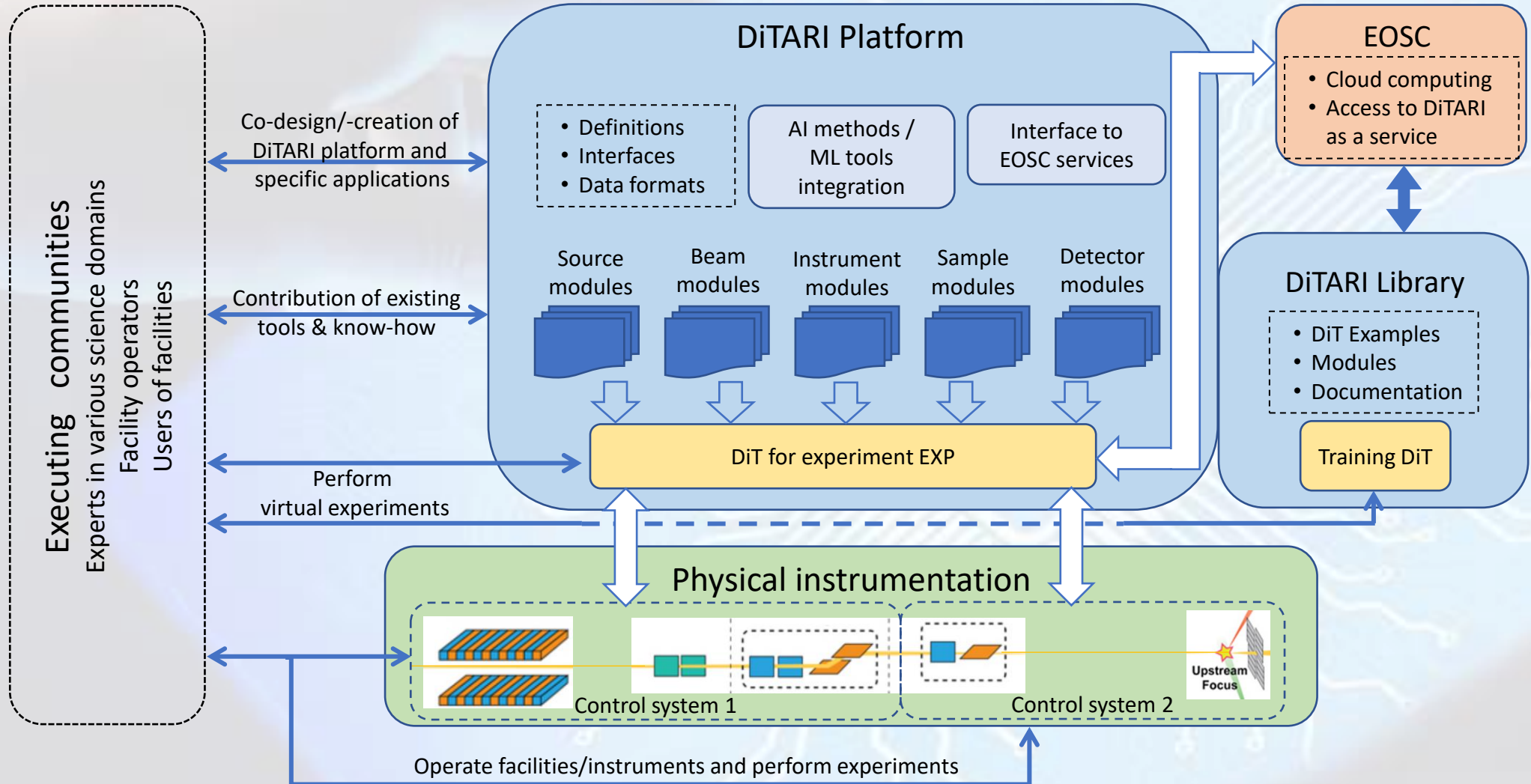
LIP - Digital Twinning

WP1-2-3. The Technology Platform

shall enable digital twinning to make preparation, execution and analysis of the experiments more effective leading to higher success rates:

- It should be **facility independent**, i.e. easily portable to increase synergies among LEAPS members
- **Enhance robust operation** of **ARI** (Analytical Research Infrastructures) facilities
- Integrate AI to allow **swift comparison** of observational and simulated data during experiments in “real-time”
- **Establish** it as a service in the **EOSC**
- **Address and include new communities** (expert & learning) by training and tutorial capability

LIP - Digital Twinning



LIP - Design activities and networking

Androids for Remote Access (ARA)

- As androids can access parts of the facility normally forbidden to people due, e.g., to radiation hazards in accelerator bunkers, they can become *the eyes and the hands of a human operator*
- Assessment of commercially available androids within the *accelerator environment*
- *Performance comparison* between androids and less advanced robots



LIP - Design activities and networking

Androids for Remote Access (ARA)

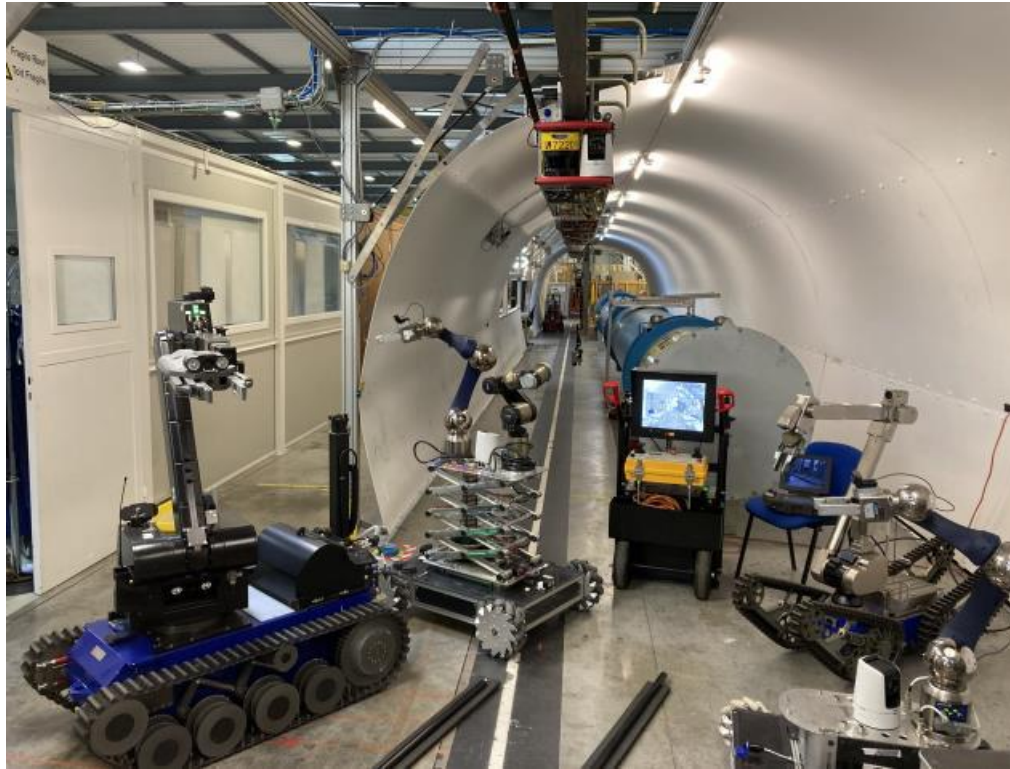
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Networking with CERN

LIP - Design activities and networking

Androids for Remote Access



Courtesy of M. Di Castro, CERN



Courtesy of André Dehne

LIP - Design activities and networking

Permanent Magnets LEAPS Internal Collaboration, PerMaLIC

*Main goal: foster transition of our Storage Ring (SR) based facilities to **low consumption, energy saving** Diffraction Limited SR (DLSR, 4th generation SR).*

Research topics:

- Tunability
- Radiation damage
- Temperature stability
- Magnetic measurements of small aperture magnets
- **Recycling / Reusing ***

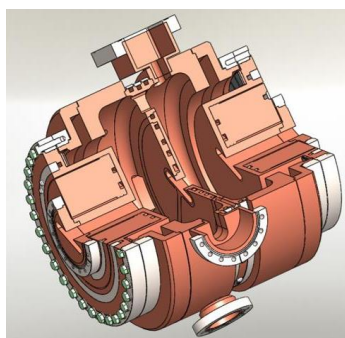
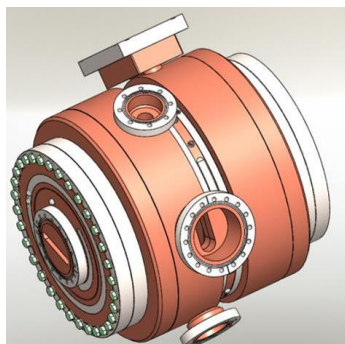


LIP - Design activities and networking: HARMONLIP

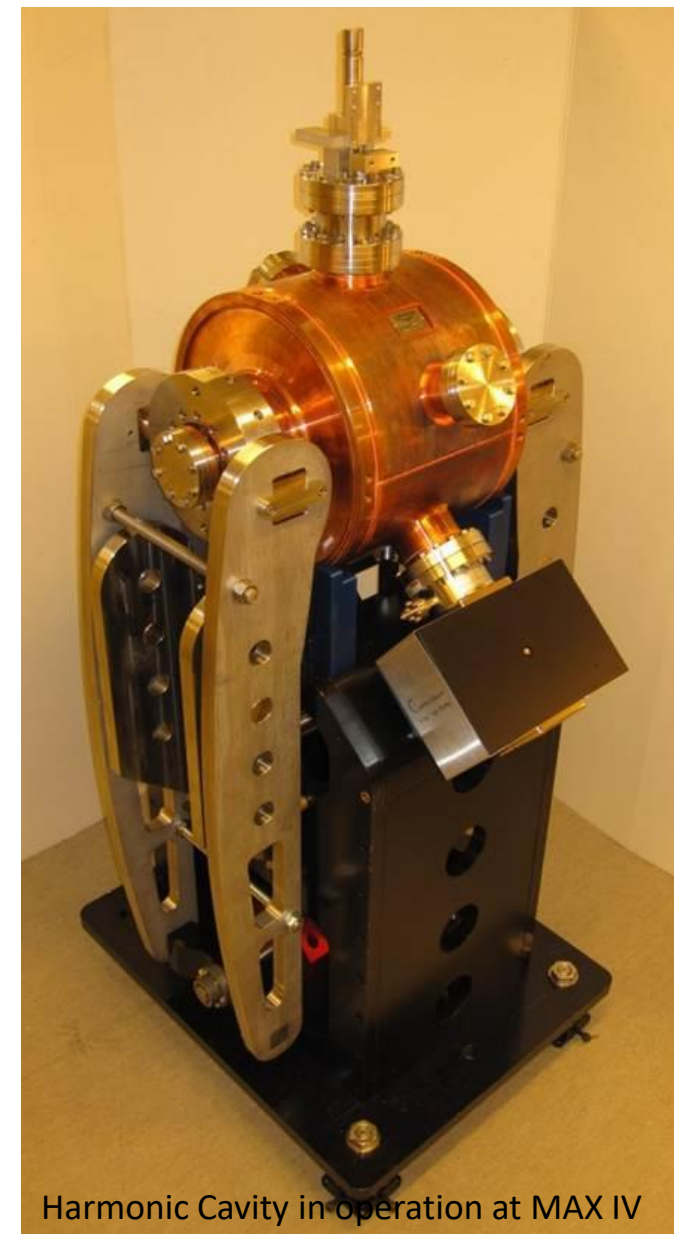
Harmonic Cavities (HCs) for *Future Light Sources*

- HCs are used since many years in third generation sources to lengthen the electron bunches in order to
 - Improve the beam lifetime
 - Improve stability

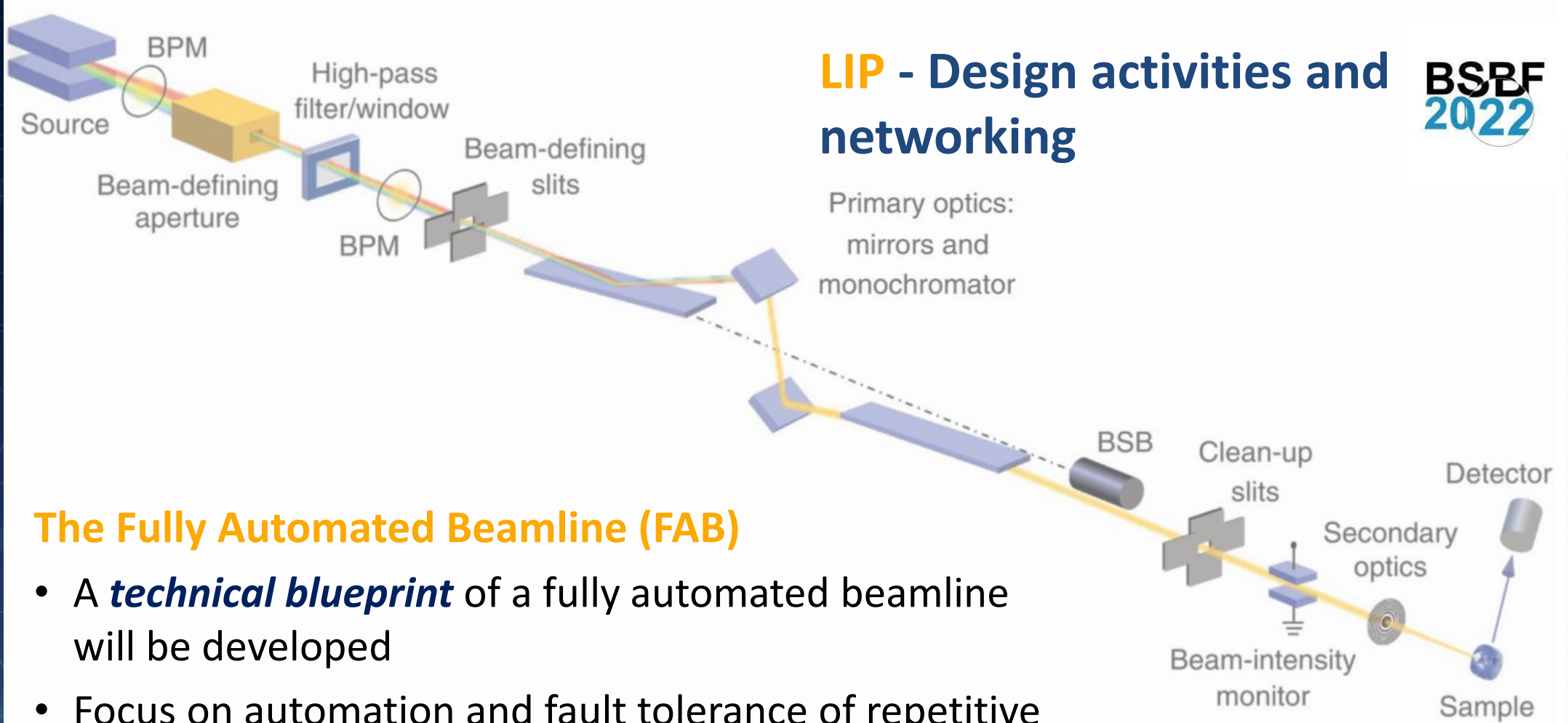
A. D'Elia, J. Jacob and V. Serrière – ESRF. ESLS-RF Nov 2021



- Main topics of *the first phase*:
 - Beam dynamics simulation tools for stretched bunches
 - Bunch-by-bunch feedback challenges for stretched bunches
 - Harmonic systems for extremely long bunches
 - Experimental Characterization of stretched bunches and stretched bunch stability
 - Intra-beam scattering for non-Gaussian bunches – theory and experiment.
 - Transient beam loading in harmonic systems



Harmonic Cavity in operation at MAX IV



LIP - Design activities and networking

The Fully Automated Beamline (FAB)

- A **technical blueprint** of a fully automated beamline will be developed
- Focus on automation and fault tolerance of repetitive tasks like:
 - beamline alignment, focus, sample alignment, fault tolerance, maintaining safe operation
 - detector calibration, software configuration, parameter selection



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DIGITAL LEAPS: STARS

Surveying Technology for Advancing Remote Services

Klaus Kiefer

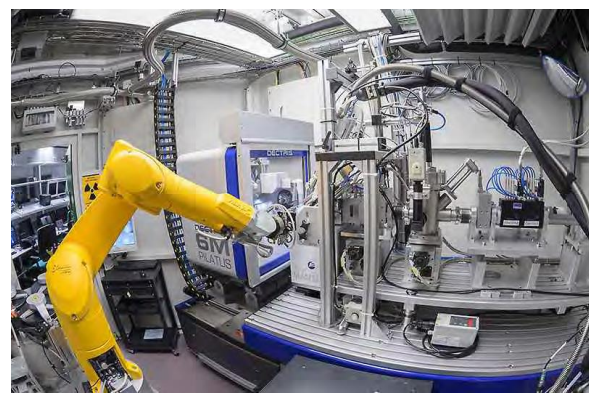
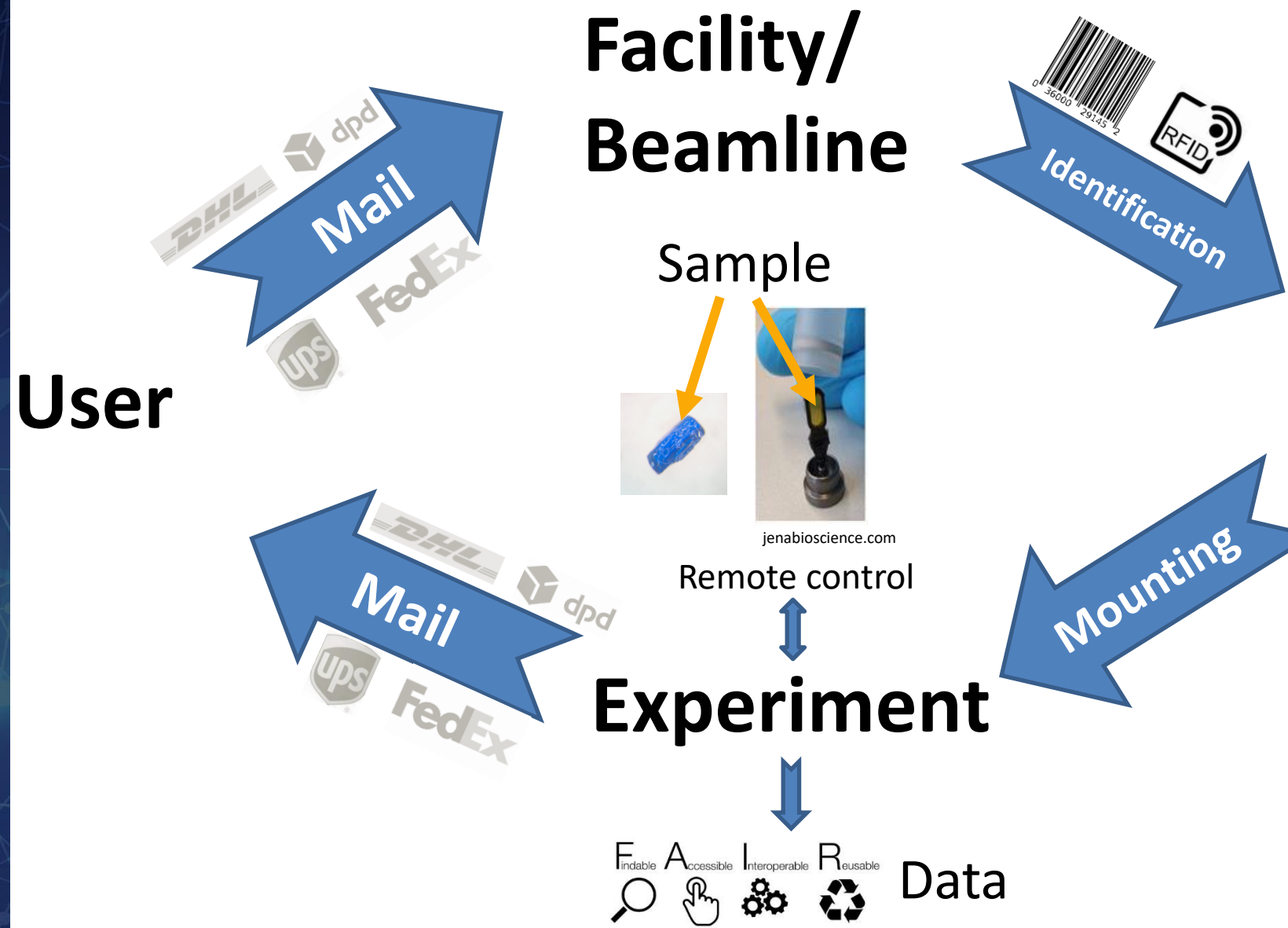
Helmoltz Zentrum Berlin

Cecilia Blasetti, Lorenzo Pivetta

Elettra Sincrotrone Trieste

STARS: Sample Life Cycle

STARS

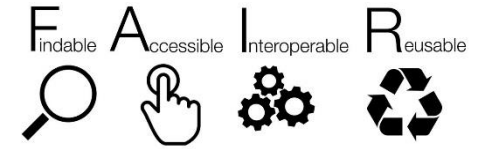


U. Mueller et al. Acta Crystallographica 70, C711 (2014)

Findable Accessible Interoperable Reusable Data

STARS: Goals

- Make **sample information F.A.I.R. compliant**
- Bring **EOSC standards** into sample handling
- Help users and user offices to **manage samples**
- Foster **automation and remote operation** at beamlines



Joint work of User Offices, IT, Sample Environment, Beam Line Scientists

STARS: Overview of procedures for mail-in sample handling

Done in 2022: survey of Mail-in and Remote Access procedures at 16 LEAPS (+ 5 LENS) facilities

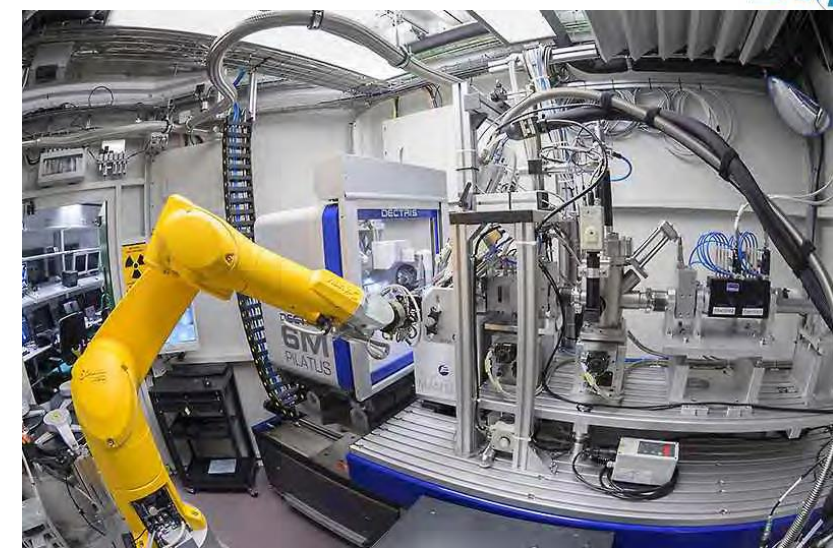
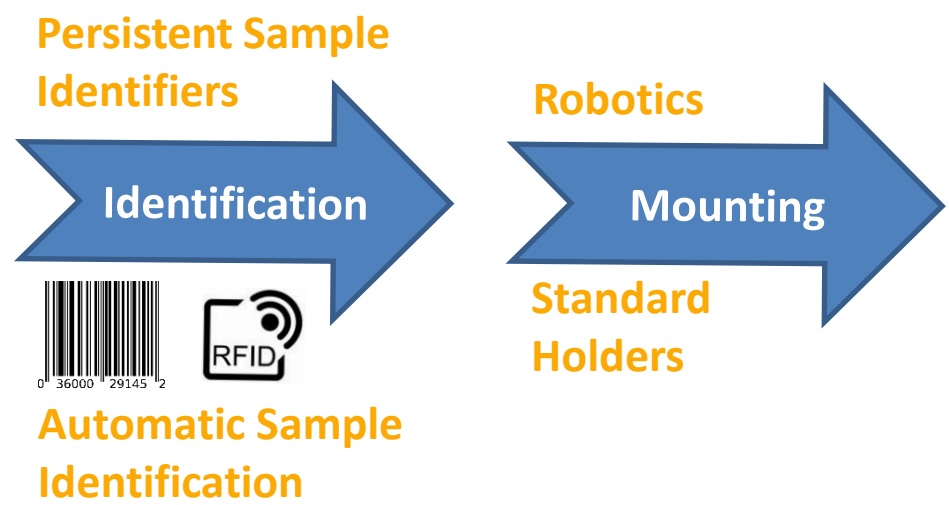
Next steps: throughout data analysis: lessons learned, best practices sharing, outlook



Focus on **logistics: examples** of information gathered

- 4 facilities use a specific tracking system for parcels, 3 track records internally
- 13 facilities cover expenses linked to parcel shipment
- 9 facilities do have a dedicated contract with couriers
- 13 facilities have a centralpoint for reception and returns of samples

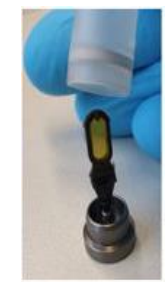
STARS: Automated Sample Handling



MX beamline Bessy II, U. Mueller et al. Acta Crystallographica 70, C711 (2014)

Industry as a **supplier**:

- Provide standardized experimental setups used at many facilities
- Provide solutions (e.g. **sample holder**) based on the standards



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Industry as a **user**:

- **Easy access** by standardized sample handling (holders, identification)
- High throughput measurements
- Reliable metadata information for samples



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Digital LEAPS: HR⁴

Enhance digital platforms for networking & training

Antonio Bonucci
European XFEL

WP1: HR⁴TECH

Digital collaborative platform
‘Innovation Mall’

- A running LinkedIn community
 - Sharing of
 - #LEAPStechnologynews
 - #LEAPSprojectupdate
 - #LEAPScallforsolution
 - #LEAPScallforpartnership



WP2: HR⁴TRAIN

Remote staff training &
Hybrid training for users

- The format in line with eRImote
- The results will be shared with the whole LEAPS community for the maximum impact



WP3: USER⁴

Collaborative platform for
Smart User Network

- Capturing of the identity of LEAPS as well as a unified LEAPS user archetype
 - The tools for collective intelligence fostering will be co-developed in HR⁴TECH



HR⁴ - Industrial applications and technological opportunities

- Call-for-partnership with automatization and tailor-made functionality → **we are looking for provider of digital platform**
- Development of the remote training software → **we are looking for new IT technology, format and digital platform**



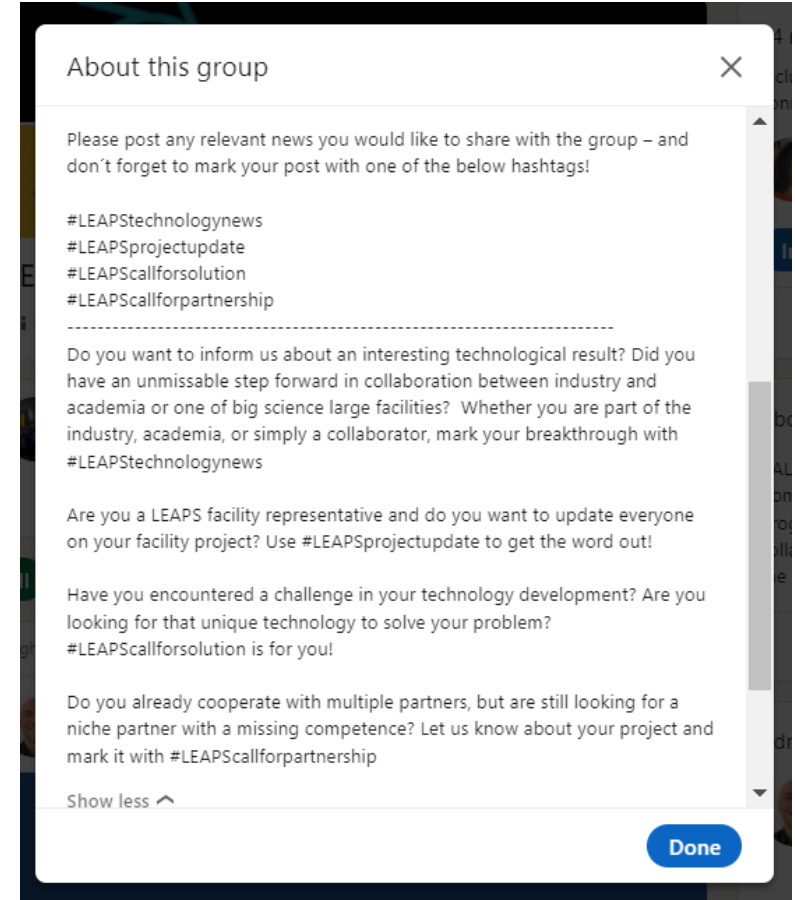
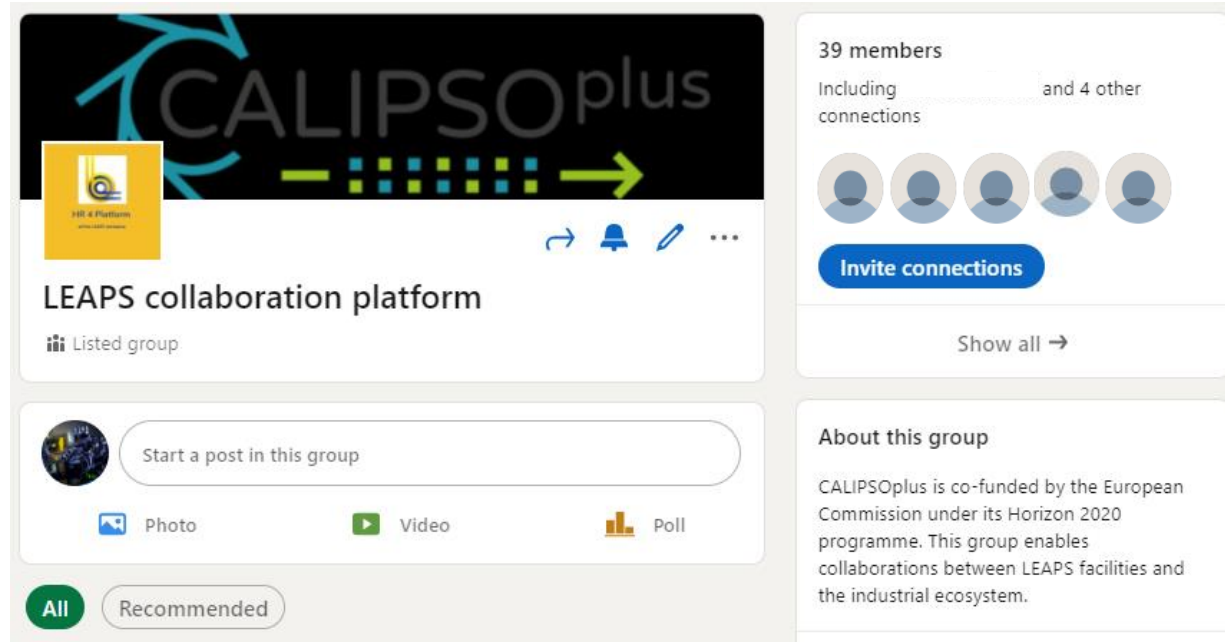
HR⁴



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JOIN HR⁴ digital collaborative platform / Innovation Mall

HR⁴



#LEAPStechnologynews
#LEAPSprojectupdate
#LEAPScallforsolution
#LEAPScallforpartnership

We encourage you to join us at
<https://www.linkedin.com/groups/12579230/>



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Outlook and Summary

DIGITAL LEAPS Outlook

- Main *implementation phase*: 2024+; *initial* foreseen *investment*: 10 to 20 M€
- *Third party funding* expected to support the main implementation phase.
- *Collaborations* will be key to develop new technologies & concepts.

DIGITAL LEAPS

aims to bring Europe's RIs to the **Digital** Forefront, Resilient, **Green** and to:

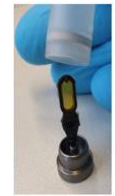
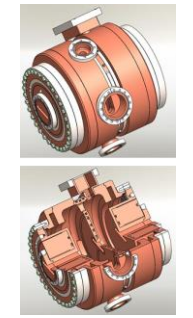
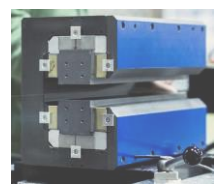
- *Open for collaborators* from other RIs from all ESFRI domains and *industry*.
- Bring *stakeholders together*.
- *Speed up* critical interphases for access and operate RIs.

In that way, LEAPS offers to invest resources wisely and sustainably, a crucial piece of a resilient research in Europe.

DIGITAL LEAPS Summary

- ✓ Digital Twinning
- ✓ Androids (ARA); Automated Beamline (FAB)
- ✓ Permanent Magnets
- ✓ Harmonic cavities
- ✓ Sample handling and logistics
- ✓ Sample holders based on standards
- ✓ Digital Collaborative Platforms

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Please contact us at the LEAPS booth @ BSBF (nr. S03, 2nd floor) or via the LEAPS Collaborative Platform



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Acknowledgments

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Lorenzo Pivetta (Elettra)

Francis Pérez (ALBA)

Alejandro Sanchez (ALBA)

Pedro Tavares (MAX IV)



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“The strength of LEAPS lies in its staff and users, hailing from all European countries, beyond those which host the facilities. Member States and facilities should optimize the funding instruments under Horizon Europe for the benefit of researchers and innovators across all Europe”

Booth S03 – 2nd floor

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<https://leaps-initiative.eu/>

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