



# Artificial Intelligence for Advancing Particle Accelerators

**Dr Joseph Wolfenden**

*on behalf of the artifact collaboration*

Successful R&I in Europe 2025, 12<sup>th</sup> European Networking Event

Düsseldorf, 6<sup>th</sup> March 2025

# Global Accelerator Landscape

>40,000 accelerators in operation worldwide<sup>1</sup>

>99% for industrial and medical applications

<1% for research and discovery science

## Main Challenges

Beam improvements and control

Impact on the environment and sustainability

Knowledge transfer and societal impact

Including design and the full machine lifetime

## How can AI help?

Operation

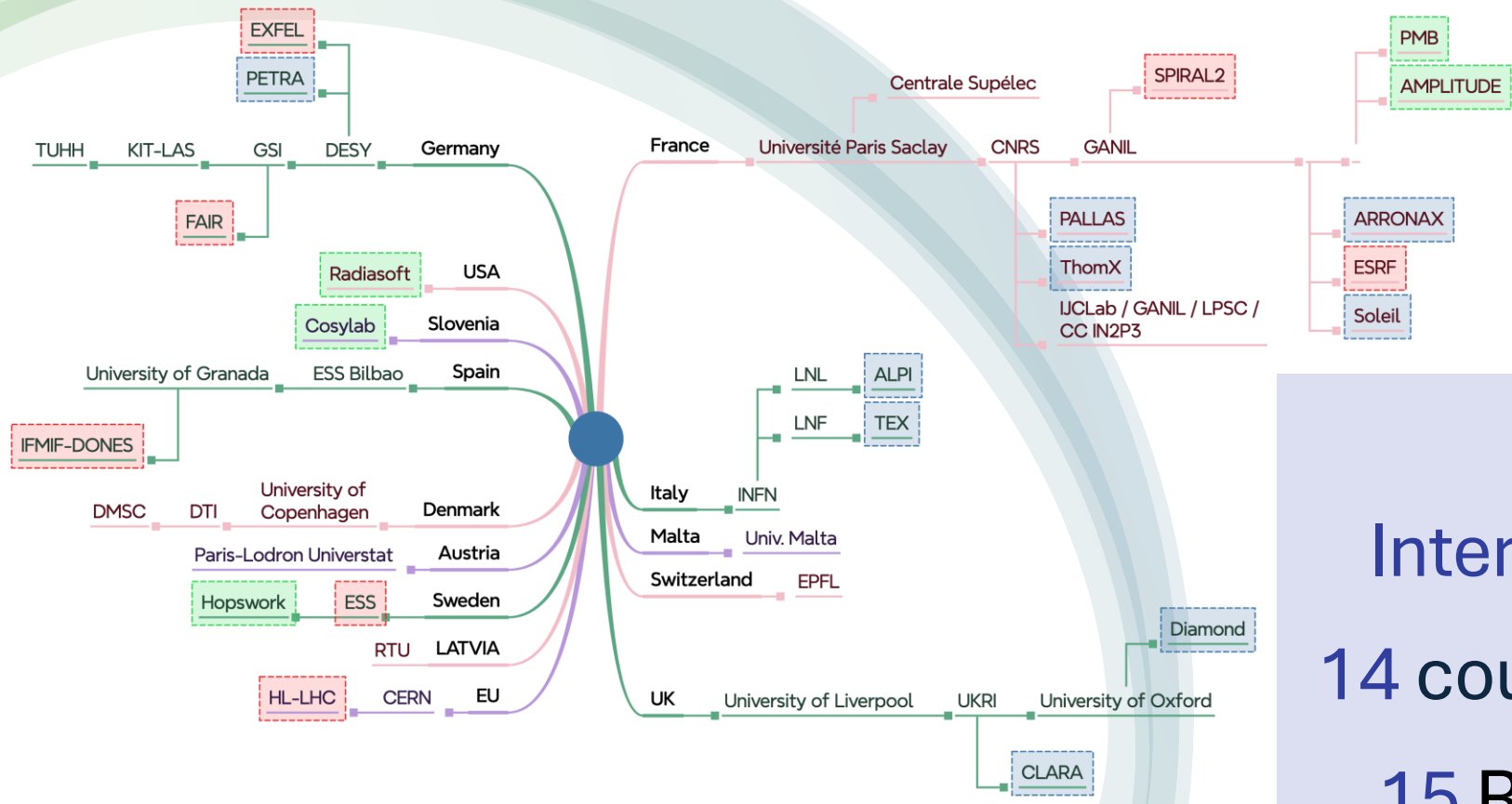
Reliability

Anomaly prevention

Optimisation

Simulation

Modelling



**Who?**

International collaboration

14 countries and 30 institutes

15 RI facilities, 7 on ESFRI

5 private companies

Extensive experience running large-scale EU-funded projects



# Deep Knowledgebase

Virtual diagnostic: FEL Current delivery

**"Machine Learning Toward Autonomous Accelerators"**  
Helmholtz AI funded project (2020-2022)

**Artificial Intelligence Applied to Photon and Neutron Science**

Nuclear Inst. and Methods in Physics Research, A

The automatic neutron guide optimizer guide bot

High precision prediction and control of magnetic fields in synchrotrons

Opportunities in Machine Learning for Particle Accelerators

**Badger**  
The Missing Optimizer in ACR

Real-Time Edge AI for Distributed Systems (READS)  
Disentangling Beam Losses in the Fermilab Main Injector Enclosure Using Real-time Edge AI

**Machine Learning Platform (MLP)**

Physicist

**Xopt**

Database

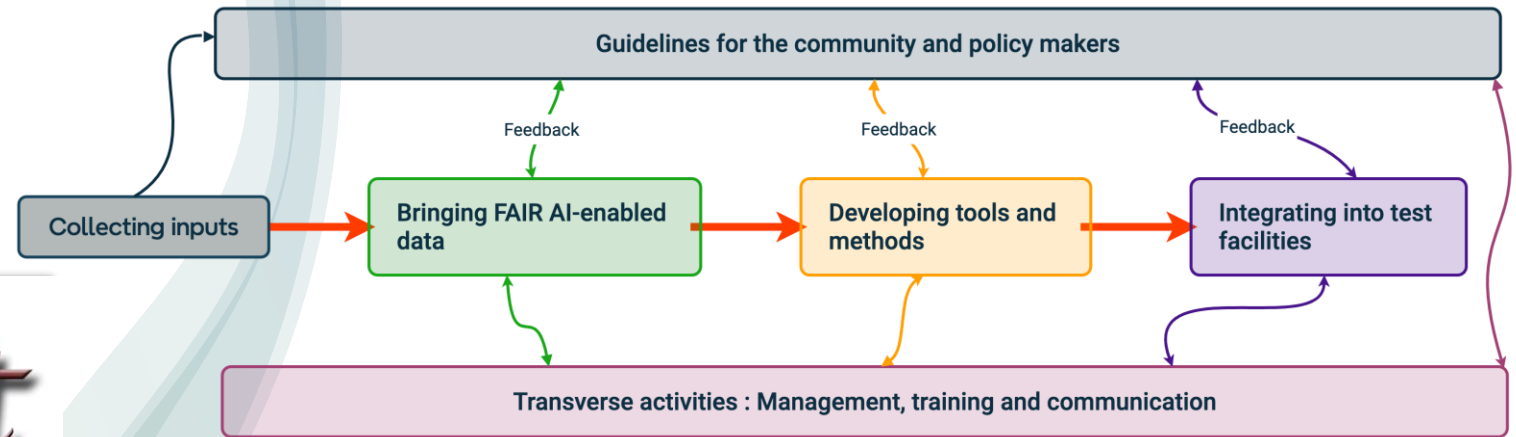
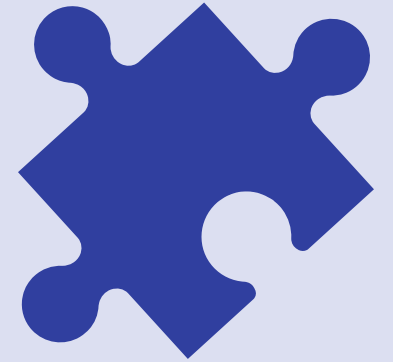
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## A Route toward Sustainable Data Generation in Accelerator Science

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**Findable**  
**Accessible**  
**Interoperable**  
**Reusable**



## Objectives

1. Reduce downtime and optimize operation
2. Develop adapted tools and methods
3. Ensure sustainable development

## Outcomes

1. Extensive cross-sector networks
2. Energy efficient operation
3. Agnostic AI-enabled control system
4. EU industry/RI roadmap

# How to get involved?

## Horizon Infrastructure calls (~10M€)

Help develop and build the AI-enabled accelerators of the future

E.g. HORIZON-CL4-2025-03-DIGITAL-EMERGING-07 – **Nov. 2025**

## MSCA Doctoral Network

Help develop and train future leaders in AI-enabled accelerators

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