



Artificial Intelligence for Advancing Particle Accelerators

Dr Joseph Wolfenden

on behalf of the artifact collaboration

Successful R&I in Europe 2025, 12th European Networking Event

Düsseldorf, 6th March 2025

Global Accelerator Landscape

>40,000 accelerators in operation worldwide¹

>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

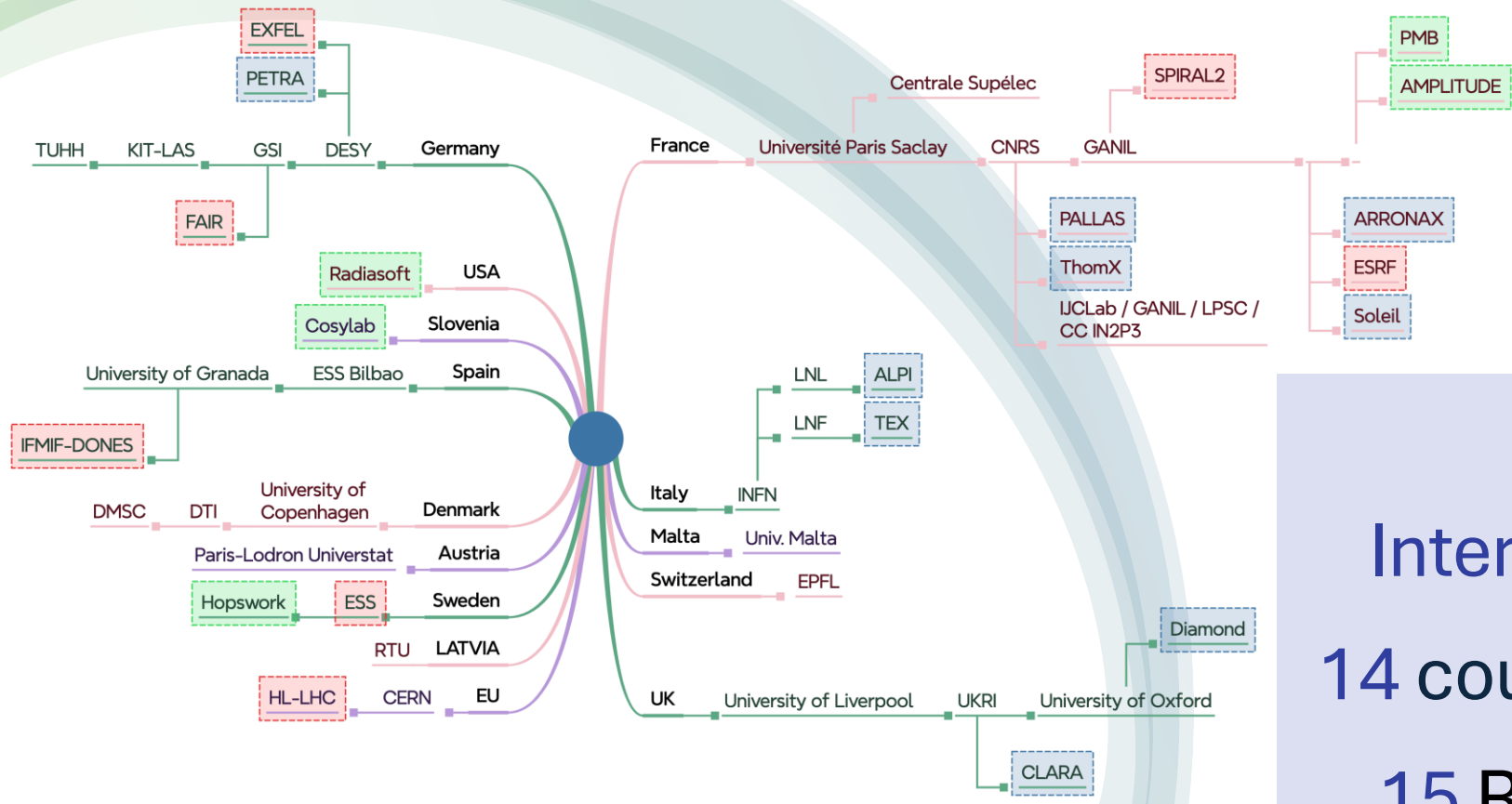
Reliability

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

MACHINE LEARNING METHODS FOR SINGLE SHOT RF TUNING

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

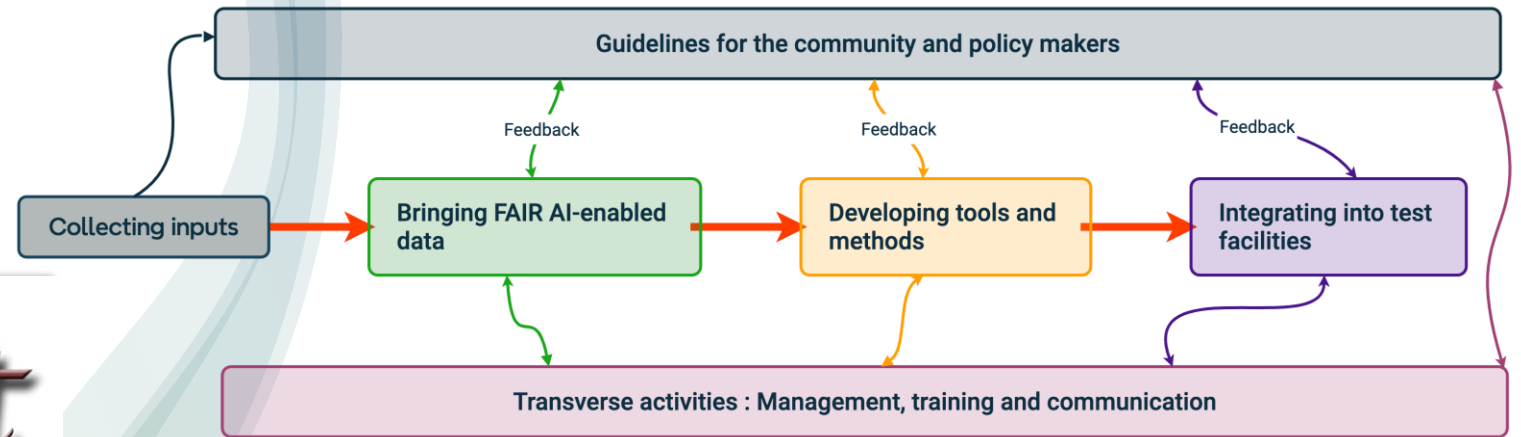
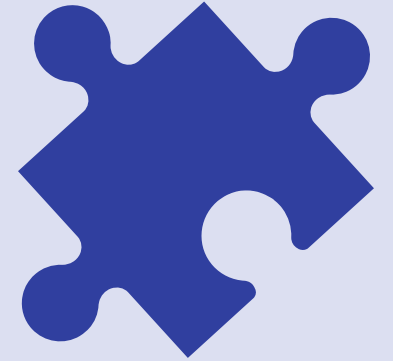
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A Route toward Sustainable Data Generation in Accelerator Science

Contributors:

Adnan GHRIBI, CEA/IRFU/CNRS/IN2P3/GANIL, France
Adrian OEFTIGER, GSI, Germany
Gianluca VALENTINO, University of Malta, Malta
Francis OSSWALD, IPHC, CNRS, France
Andrea Santamaria Garcia, KIT, Germany
Chenran Xu, KIT, Germany
Kevin Cassou, IJClab, CNRS/IN2P3, France
Viacheslav Kubysky, CNRS/IN2P3, France
Hayg Guler, CNRS/IN2P3, France
Amelia Pollard, ASTeC, Daresbury, UK
Damien MINENNA, CEA/IRFU, France
Barbara Dalena, CEA/IRFU, France
Quentin Druant, CEA/IRFU, France
Francesco Massimo, LPGP, CNRS, France
Brigitte Cros, LPGP, CNRS, France

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

Get in touch:

Prof. Carsten P. Welsch
welsch@liverpool.ac.uk

