AI Roadmap at IN2P3

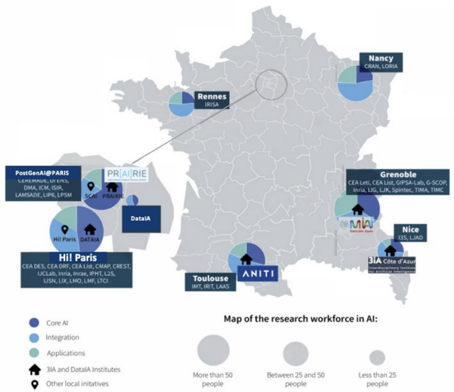
FCPPN/L Workshop
29 june – 03 july 2026, Lyon

Julien Donini (LPCA, UCA)

Context: AI in France and EU

CNRS

- AISSAI center (AI for science, science for AI)
- Working group: generative AI for sciences
- Computing: CC-IN2P3, GENCI (Jean Zay)
- Engineering network: PNRIA



National strategy (ANR)

- 9 IA Clusters ; 2 PEPR : NumPEX et PEPR IA

UE

- Resource for AI Science in Europe: RAISE
- Supercomputers: AI factories and giga-factories (EuroHPC JU)
- AI strategy at CERN

AI @ IN2P3 : Physics domains

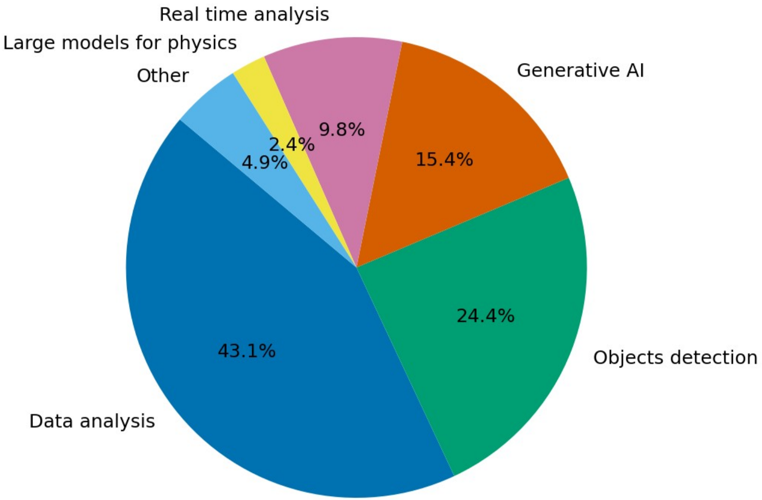
Long used in many scientific fields at IN2P3 : From ‘**classical**’ machine learning (1980s–90s) to **modern AI advances** (over the last 10–15 years)

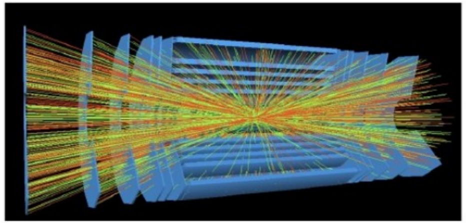
Many use-cases and developments :

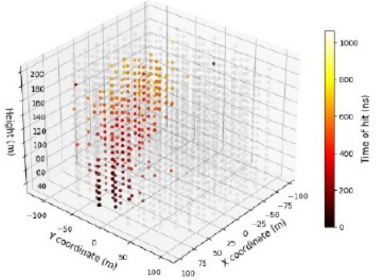
- Particle **identification** at the LHC
- **Real-time** calorimeter readings
- Fast **simulation** of complex detectors
- Analysis of telescope **images**
- **Estimation** of cosmological parameters
- **Description** of nuclear reactions
- Online **control** of accelerators
- ...

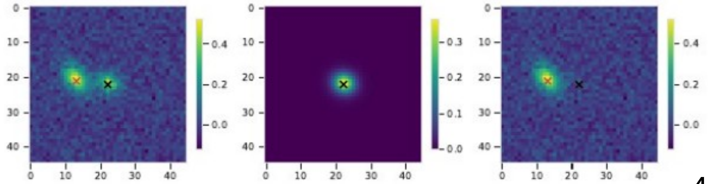
AI @ IN2P3 : Application and tools

- **Deep learning** (CNN, Transformers, U-Net)
- **Graph-based learning** (GNNs, graph convolutions
- **Generative models** (GANs, diffusion)
- Probability density modelling (normalizing flows)
- Bayesian ML / **simulation-based inference**
- **Time-series** representation learning
- Real time **ML** on FPGA, embedded systems
- Natural language models, **LLM**
- (Multi-Agents)





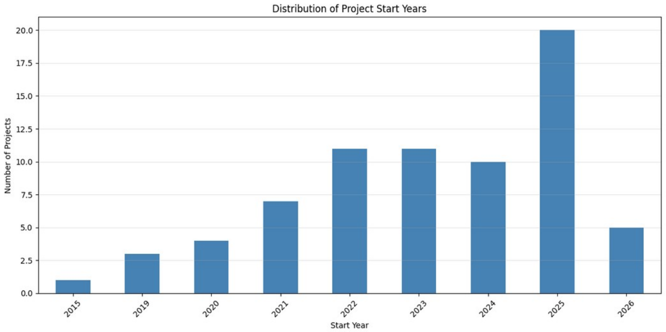


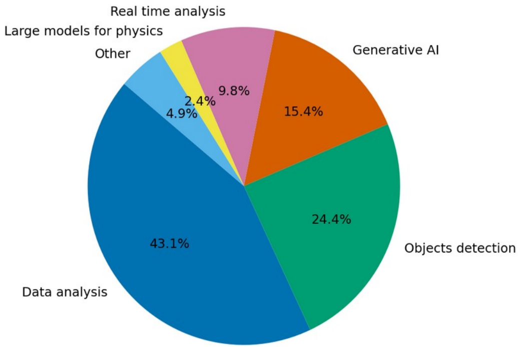


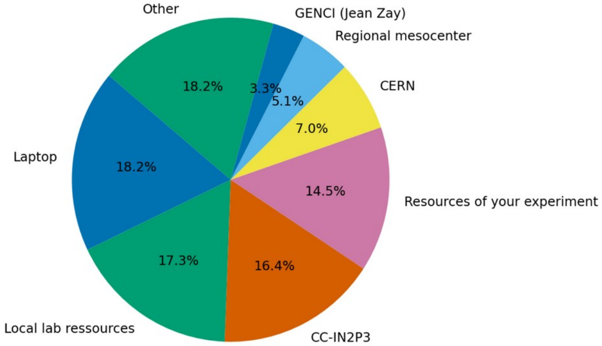
AI @ IN2P3: Current status

Survey (self-reported) conducted in October 2025

- more than 70 research and engineering projects identified : total ~**100 FTEs**







Key findings

- Need to strengthen **support** for AI engineering and AI experts: development and scaling
- Need to professionalize **AI workflows** and establish best practices for benchmarking

FINK : Analysis of transient objects


Accueil › Espace presse

Au plus près des étoiles avec Fink, l'outil français d'analyse des phénomènes transitoires dans l'Univers observable

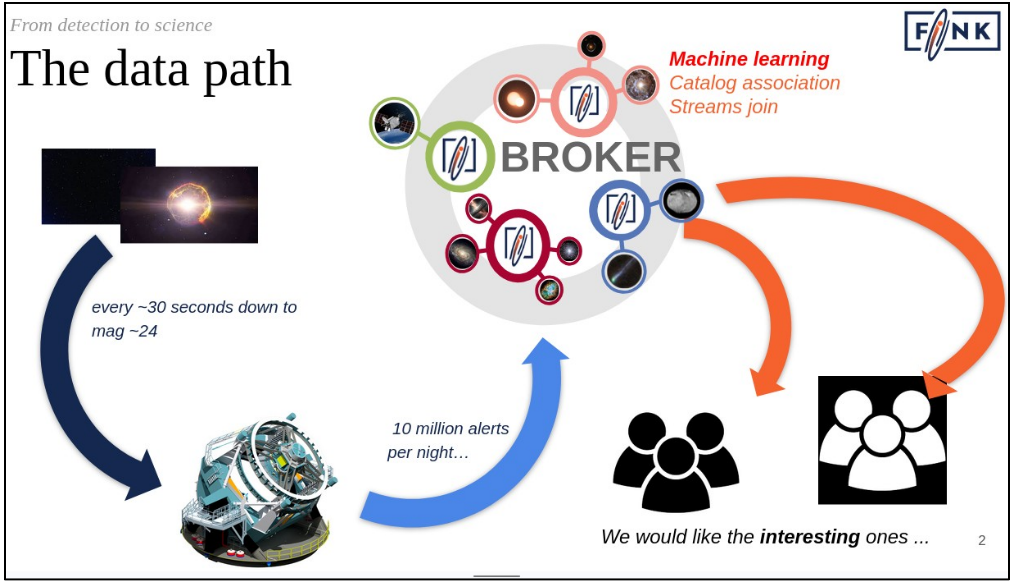
25 février 2026

UNIVERS

© NSF-DOE Observatoire Vera C. Rubin.

Processing the stream of images from the **Vera C. Rubin Observatory**

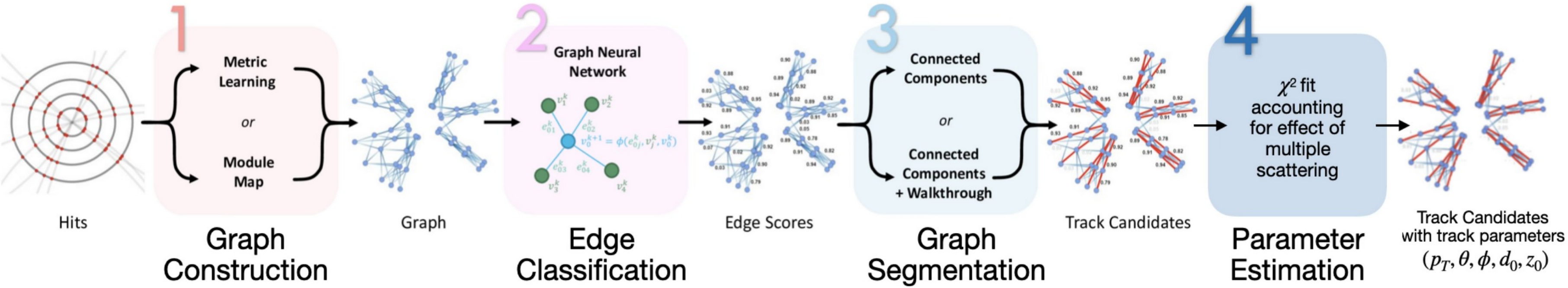
Data selected (by AI) and shared with the astrophysics community



Observations made that same night at the Siding Spring Observatory in Australia: path: Chile → United States → France → Australia → 2 minutes

E. Ishida

GNN4ITk : reconstruction de traces pour le LHC

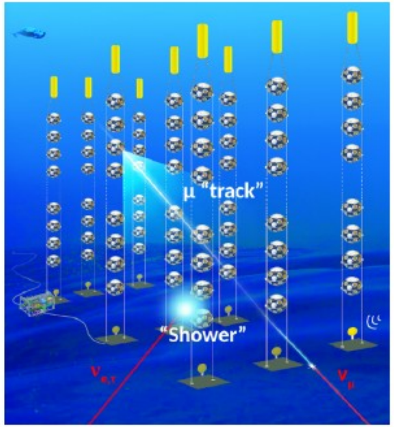


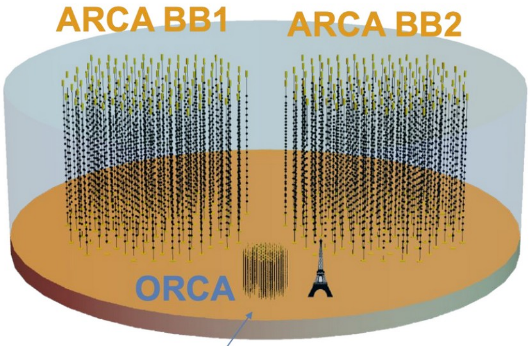
A **Graph Neural Network** (GNN) model learns to recognise the geometric patterns in the traces and assigns a score representing the probability that it is a particle segment.

5 years of R&D; the project being optimised and evaluated with a view to its deployment for the HL-LHC

S. Caillou

Neutrino telescope for KM3Net





2 types of telescope

- ORCA: low energy neutrinos
- ARCA: high energy

30% of operational lines and data collection

How can we generalise this across different line configurations and physical domains?

Foundation models for physics

Models trained on a variety of data and detector configurations converge towards a common representation of the data

A. Vacheret

What's coming (is already here)

Generative AI and autonomous AI agents for physics

Theory

Resummation of the C-Parameter
Sudakov Shoulder Using EFT

$$
\begin{aligned}
c_H^1 &= C_F\left[-\frac{65}{4}+\frac{3\pi^2}{2}-\frac{21}{8}\ln 3-10\ln 2\ln 3+3\ln^2 3+10\,\mathrm{Li}_2\!\left(\tfrac{1}{3}\right)\right]\\
&\quad + C_A\left[\frac{3}{4}+\frac{5\pi^2}{4}+\frac{3}{8}\ln 3+\ln 2\ln 3-\frac{3}{2}\ln^2 3-\mathrm{Li}_2\!\left(\tfrac{1}{3}\right)\right],\\
c_S^1 &= \mathcal{C}\left(-\frac{2\pi^2}{3}+4\ln^2 2-\frac{1}{3}\ln 27\ln 48+2\,\mathrm{Li}_2\!\left(-\tfrac{1}{3}\right)\right).
\end{aligned}
$$

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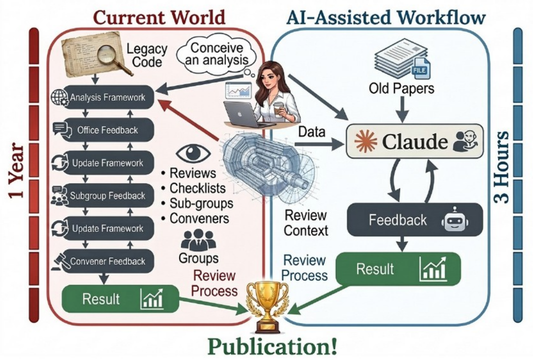
HEP

AI Agents Can Already Autonomously Perform Experimental HEP



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Resummation of the C-Parameter Sudakov Shoulder Using EFT

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\begin{aligned}
c_H^1 = C_F &\left[-\frac{65}{4} + \frac{3\pi^2}{2} - \frac{21}{8}\ln 3 - 10\ln 2\ln 3 + 3\ln^2 3 + 10\,\mathrm{Li}_2\!\left(\tfrac{1}{3}\right)\right] \\
&+ C_A\left[\frac{3}{4} + \frac{5\pi^2}{4} + \frac{3}{8}\ln 3 + \ln 2\ln 3 - \frac{3}{2}\ln^2 3 - \mathrm{Li}_2\!\left(\tfrac{1}{3}\right)\right], \\
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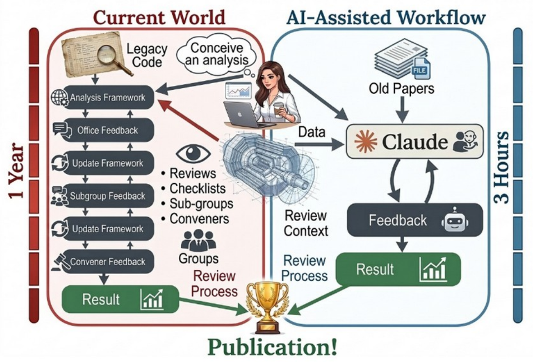

Design of experiments

GRACE: an Agentic AI for Particle Physics Experiment Design and Simulation

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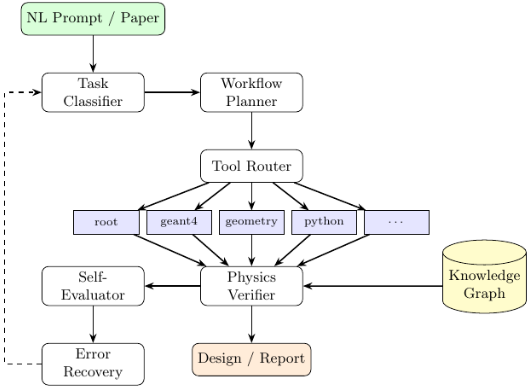
Resummation of the C-Parameter Sudakov Shoulder Using EFT

$$c_H^1 = C_F\left[-\frac{65}{4} + \frac{3\pi^2}{2} - \frac{21}{8}\ln 3 - 10\ln 2\ln 3 + 3\ln^2 3 + 10\,\mathrm{Li}_2\!\left(\tfrac{1}{3}\right)\right]$$
$$+\, C_A\left[\frac{3}{4} + \frac{5\pi^2}{4} + \frac{3}{8}\ln 3 + \ln 2\ln 3 - \frac{3}{2}\ln^2 3 - \mathrm{Li}_2\!\left(\tfrac{1}{3}\right)\right],$$
$$c_S^1 = \mathcal{C}\left(-\frac{2\pi^2}{3} + 4\ln^2 2 - \frac{1}{3}\ln 27\ln 48 + 2\,\mathrm{Li}_2\!\left(-\tfrac{1}{3}\right)\right).$$



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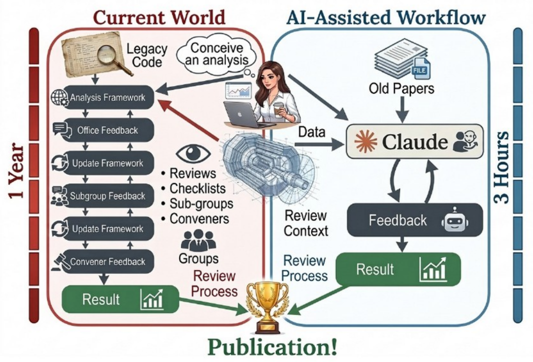

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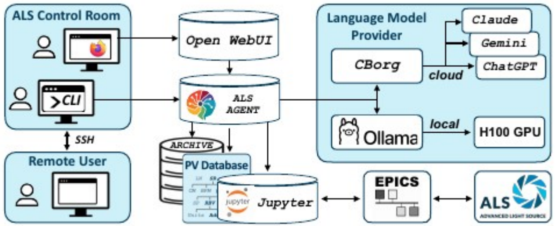
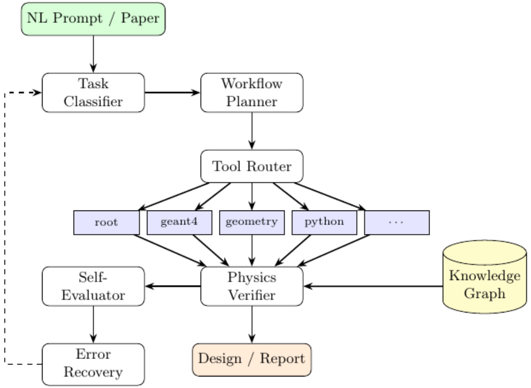
Accelerators Assistant
Agentic AI for Multi-Stage Physics Experiments at a Large-Scale User Facility Particle Accelerator



Design of experiments
GRACE: an Agentic AI for Particle Physics Experiment Design and Simulation



Generative AI for science

Journée GT COMP (CNRS) - **"IA générative pour les sciences"**

Programme

Mercredi 24 juin 2026

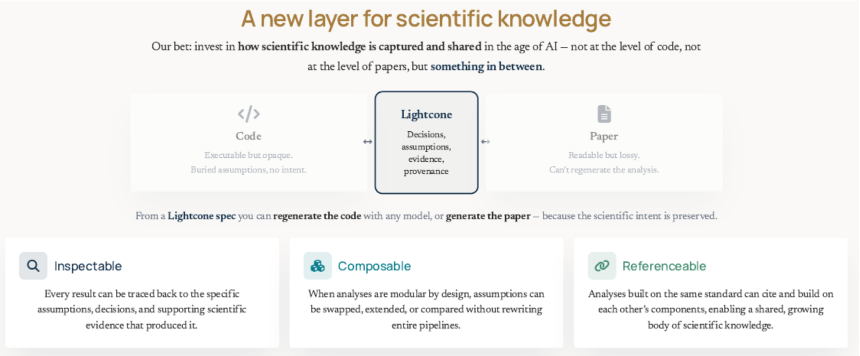
Auditorium Marie Curie - Siège du CNRS - 3 rue Michel-Ange 75016 Paris

9:00 - 9:30	**ACCUEIL CAFÉ/ THÉ (ANNEXES AUDITORIUM)**	
9:30 - 9:45	**Introduction** Martina Knoop, mission pour les initiatives transverses et interdisciplinaires (MITI) du CNRS	
9:45 - 10:15	**Défi « IA générative pour les sciences » : Vision, Ambitions et Plan d'Action**	
10:15 - 10:30	**Échanges et Perspectives : Dialogue avec le GT du COMP**	
10:30 - 12:50	**IA générative et agentique : quelques cas d'usage en sciences**	
	10:30 - 11:00	**L'IA résout-elle les mathématiques ?** Marc Lelarge, ENS Paris - PSL / Inria
	11:00 - 11:30	**Réflexions historiques inspirées par l'irruption de l'Intelligence Artificielle en mathématiques** Karine Chemla, CNRS - Académie des sciences
	11:30 - 11:40	**Dialogue croisé avec les intervenants** Karine Chemla, CNRS - Académie des sciences Marc Lelarge, ENS Paris - PSL / Inria
	11:40 - 12:10	**Données Complexes, IA et dialogue inter et intra-disciplinaire** Mathieu Aubry, École des Ponts Paris Tech - IP Paris
	12:10 - 12:40	**Les défis liés à la représentation des données physiques dans les modèles d'IA** Antonin Vacheret, CNRS
	12:40 - 12:50	**Dialogue croisé avec les intervenants** Mathieu Aubry, École des Ponts Paris Tech - IP Paris Antonin Vacheret, CNRS
12:50 - 14:00	**DÉJEUNER (SALLES JEAN PERRIN ET FRÉDÉRIC JOLIOT-CURIE)**	
14:00 - 16:30	**IA générative et agentique : quelques cas d'usage en sciences - suite**	
	14:00 - 14:30	**Vers un écosystème ouvert pour une science transparente et vérifiable à l'ère de l'IA agentique** François Lanusse, CNRS
	14:30 - 15:00	**Le virage (et les mirages) de l'IA générative en sciences de l'environnement et du climat** Julien Le Sommer, CNRS
	15:00 - 15:10	**Dialogue croisé avec les intervenants** François Lanusse, CNRS Julien Le Sommer, CNRS
	15:10 - 15:20	**PAUSE (ANNEXES AUDITORIUM)**
	15:20 - 15:50	**Quels systèmes agentiques pour accélérer la découverte de nouvelles molécules ?** Élise Dumont, Université Côte d'Azur
	15:50 - 16:20	**L'IA pour la science des matériaux : promesses et challenges** Mario Maglione, CNRS
	16:20 - 16:30	**Dialogue croisé avec les intervenants** Élise Dumont, Université Côte d'Azur Mario Maglione, CNRS
16:30 - 16:45	**Clôture** Stéphane Canu, Ministère de l'enseignement supérieur, de la recherche et de l'espace	

Objective: design, develop and deploy a generative, multi-agent AI platform for sciences at CNRS

LightCone Research project (CNRS/U. Berkley)

https://lightconeresearch.org/



F. Lanusse

AI strategy at IN2P3

Create an environment favouring to the development and support of AI projects with significant scientific impact at IN2P3

Operational support for research projects:

- **AI engineers** to support research projects
- **Benchmarks** and **services** to ensure project reproducibility

Structuring of AI activities

- Creation of an **GDR** integrating AI, computing, and services
- Enhanced **support** for projects led by early-career researchers

Strategy presented in a **document** that will be distributed more widely throughout the institute

Initiative to be aligned with the **strategy for computing, data, and open science**

Conclusion and prospects

AI developments at IN2P3 span all areas: from design to sensors and on to the analysis of results.

The institute's AI Strategy aims to **support AI research projects at IN2P3** and to **structure AI coordination efforts**, notably by proposing a **GDR**.

This work is part of the **institute's computing and data strategy**, which must take into account AI, open science, technical developments, skills needs, and **HR developments**

To meet the standards of scientific rigor and performance, we need to teach machines to "Think like a Physicist"

E.g.: symmetries, robustness to systematics, exactness guarantees, statistical inference, …

Jesse Thaler (MIT)

Summary

IN2P3 has a long-standing use of AI across multiple scientific domains: particle physics, nuclear physics, astroparticle physics, cosmology, medical physics, accelerators...

- Fast adoption of **recent AI advances** (e.g. graph neural networks, transformers, normalising flows) in several institute projects
- Projects at varying maturity levels, ranging from **proof-of-concept studies to large-scale deployments**
- AI as a **major scientific driver**, enhancing the performance of existing analyses, enabling new research opportunities and opening novel scientific directions.

An **AI for science strategy** is currently being developed to support and structure **AI-related activities at IN2P3**, while integrating them into **national and European initiatives**.

Backup

AISSAI

AISSAI : Center AI for Science, Science for AI

- Dialogue between the 10 CNRS institutes
- Scientific outreach: workshop, schools, hackathon
- Scientific support: calls for postdocs, visiting researchers
- International network: IVADO, Helmholtz AI, U. Chicago, Singapore
- AI strategy and national science (COMP) and the EU

AI for science, science for AI

AISSAI et l'IN2P3

2023-2024 : 3 international workshops, 1 school, 1 hackathon

2025 : 1 post-doc (18 months, KM3Net)

2026 : workshop, school AI agents (AI for metascience)