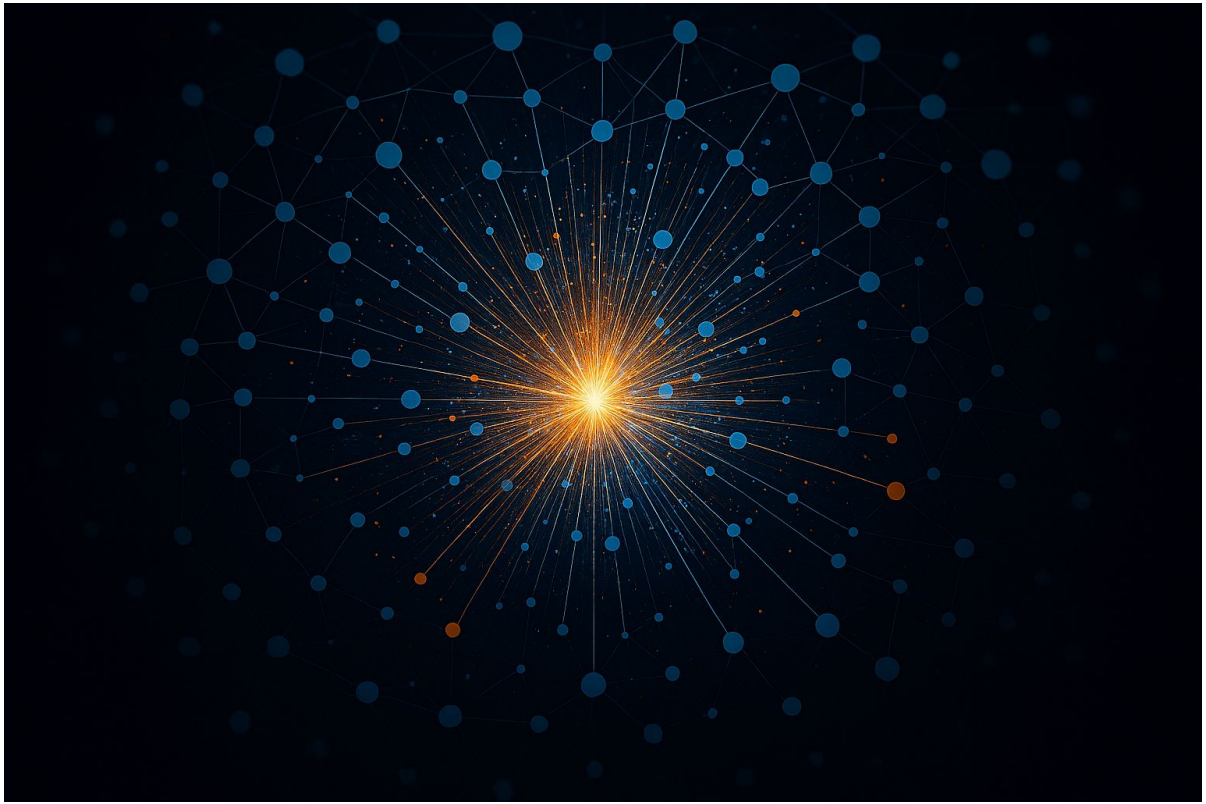
Community-driven AI whitepaper for High Energy Physics

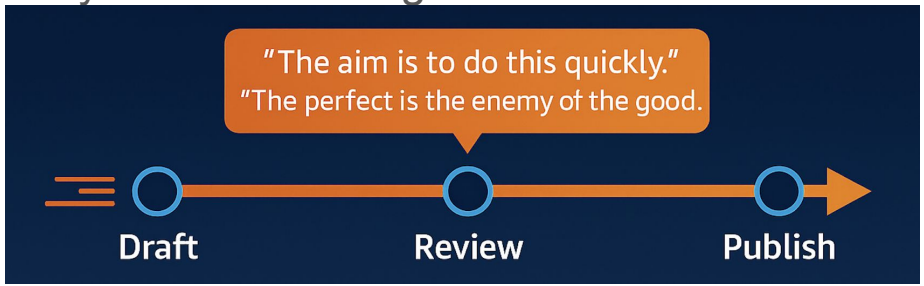


Goals of the whitepaper

- What are we trying to achieve and why ?
  - Target audience
    - **Funding agencies, policy makers**, external collaborators (industry…), our own community
  - What does HEP gain from this ?
    - A **vision** for how AI can advance our science - current/future experiments
  - What benefits does it bring to us ?
    - Connect w/ Genesis and other potential funders (NSF, private)
- What it is not ?
  - Not an exhaustive review of all ongoing AI/ML activities and projects, but a **bigger picture view** for external consumption.

Process and Timeline

- Invited input from community
  - this google doc (https://bit.ly/HEP-AI-paper)
  - Deadline for input: **Sunday, January 18th, 2026**
- **Deliverable: convert list/ideas into prose and coherent vision**
  - First draft of whitepaper by **Feb 1, 2026**
- Invite endorsements and/or comments on the whitepaper from the community
  - Deadline: **Feb 8, 2026**
- Finalize whitepaper and upload on arXiv shortly thereafter
  - Prioritize timely actionable insights over exhaustive detail



Vision

- Needs to be bold, ambitious (aspirational ?)
  - Connect with P5 and NAS reports and science goals
  - How AI can enable our ambitious vision - what are the Grand Challenges ?
  - Why the HEP community can drive this innovation ?
  - How labs and universities can work together ? [Note DOE RFI]
  - What can be demonstrated in the next some years en route to the ultimate goal ?
    - Current/planned experiments
    - Big projects and small experiments

Grand Challenges ?

- Overall: Make HEP experiments AI-native ?
  - AI agents that design, operate and analyze experiments
    - Digital twins for next-gen accelerators/detectors ?
    - Automation of operations
    - AI Scientist (improve time-to-insight…)
  - Train scientific foundation models on collider and neutrino data [more in talk by Michael+Lukas]
  - Role of human scientists in an AI-native HEP future
  - What can we deliver in the near term ?
    - demonstrators for HL-LHC, DUNE, future colliders…
  -

Thoughts on a “Collaboration”

- A collaboration spanning U.S. labs, universities -and- experiments.
- We aim to build an AI infrastructure for particle physics, an information space community “laboratory” distinct from but serving the physical laboratories.
- The minimally viable size for the most ambitious goals is likely >100FTE (likely spread across o(twice) that number of people), perhaps $150M (?) for 5 years?
- Although it is a “collaboration”, in order to make it successful, we should be aiming for joint management of potentially several funding sources (DOE, NSF, private foundations) rather than the BYOB-style of the experimental collaborations. “Joint management” can be modeled on the US LHC operations programs, with inspiration from IRIS-HEP, HEP-CCE, CompHEP Traineeships.
- Joint management of the large US funding pieces facilitates the definition (in partnership with the experiments!), pursuit and evolution of specific “grand challenge” activities.
- There will be “research” elements to it, but guided specifically by the “grand challenges” we would be working explicitly towards building this information space “laboratory”, i.e. an AI infrastructure for particle physics supporting the full life cycle of experiments.
- It would also provide an “Intellectual Hub” for international and industry partnerships, and a connection point for other (smaller) R&D activities.

Whitepaper content

1. We should present an ambitious and exciting **community vision** of transforming the way HEP does science.
2. The aggregate result should be potentially be **order(s) of magnitude** in terms of impact.
3. In addition to the community connecting with this vision, we need to be able to explain it in terms that will be exciting for policymakers/funders.
4. We should aim not only for a vision that the community can endorse, but also make this a pitch for how **we can build a national scale collaboration** to pursue this (spanning DOE labs, universities and experiments, and providing contact points for collaborations with industry).
5. Given that the timescale for writing the whitepaper is short, it cannot be a detailed review of all ongoing or proposed projects.
6. We received quite a bit of community input in the google doc. The granularity of the input varies: there are a number of ideas for specific projects as well as some more “visionary” contributions. We need to do some “impedance matching”/coalescing such that those who provided input/ideas see their connection to the global vision, but without the whitepaper turning into a laundry list.

Plan for the Workshop

- Thursday AM
  - Introduction
  - Foundation Models and Agentic Science (Michael, Lukas)
  - Discussion
- Thursday PM
  - Discussion
    - What are the main themes (research directions ?) emerging ?
      - Review also the google doc
      - Organization of the document
    - Divide up the work and start writing
- Friday AM
  - Discussion: open items/questions
  - Continue writing
- Friday PM
  - Closeout and homework assignments