Information to collect for each Nikhef research program

- **A - Current situation – production use of AI/ML**

  NB: For this inventory we only consider 'modern large-scale AI/ML techniques' in the scope of this survey (i.e. not BDTs and/or lightweight NNs etc)

  - **Where is the major current impact of AI in your research area?**
    - **1.1)** What are the **physics areas of application** where AI is having a major impact internationally in production use in your research area?
      - Briefly sketch the **purpose of application** and what **ML/AI architectures/techniques** are currently used (LLM, GNNs etc…) along any with major **computing resource requirements** (for training / for application)
  - **What is the involvement of Nikhef scientists in current efforts?**
    - **2.1)** Are you **involved in** or **internationally leading in** R&D* on the application of AI/ML methods in your research area? Or are you mainly 'end-users'?
    - **2.2)** Who are the **in-house experts**? What is their **expertise?** Please distinguish staff vs PhD/PD expertise.
    - **2.3)** To what extent use **MSc/BSc projects** in your group focus on AI/ML use? Do you have experience with Comp.Science (AI) and/or Math students (Bsc/Msc/PhD) in your group working AI/ML in physics?
    - **2.4)** Are you (at Nikhef) using **AI-based coding assistance tools?**

* AI/ML R&D here = research and *development of ways to deploy AI/ML techniques within your research domain* not core computer-science research of entirely new AI techniques

Information to collect for each Nikhef research program

- **B – Mid-term future (2-4 years) – effects of ongoing R&D in known AI/ML**
  On scale of O(3) years future of ML/AI in HEP is reasonably predictable, since it is dominated by deployment of currently known AI/ML techniques and less on unpredictable emergence of new techniques
  - **What is the expected ML/AI use in your research area in the next years?**
    - **3.1)** Extrapolating from current experience, where will **future/improved deployment of ML/AI** bring **strong gains in physics performance** in the next few years?
      What AI/ML **techniques** do you expect to perform strongly in the near future
      (LLMs, foundation models, simulation-based inference, generative models etc etc)
    - **3.2)** Are there major **novel ML/AI application** areas in the pipeline? (i.e. areas where ML is now not used)
    - **3.3)** What are the expected future **computing resource requirements** (for training / inference)?
  - **What is the involvement of Nikhef scientists in ML/AI deployment R&D for next years?**
    - **4.1)** What is the **ambition** of your Nikhef research program for AI/ML use and deployment R&D?
    - **4.1**) Are there **clear leading institutes/consortia** in the international field in these R&D efforts?
    - **4.3)** How do **Nikhef efforts compare** to these in **a)** expertise, **b)** person-power, **c)** infrastructure?
    - **4.4)** Who are your **partners nationally and internationally** in your efforts & ambitions?
    - **4.5)** What **expertise, person-power, infrastructure are you missing** to compete effectively and/or realize your ambitions?
    - **4.6)** What are your expectations and/or plans related to AI-driven **coding assistance** and/or **ChatGPT-style AI** (physics) knowledge services?

Information to collect for each Nikhef research program

- **C – Long-term future (5-10 years) – future directions**

  Given the pace of developments in AI/ML, predicting the evolution of its future possibilities on a 5–10y scale is rather speculative.
  Instead, here we focus on *future application areas* where disruptive improvements in AI/ML can make a difference

  - **Thinking 'Disruptively Big': what research applications are a good target for future AI methods**
    - **5.1)** What are **problems 'of interest' that are currently unsolvable** (from practical computational point of view) but could be solvable with disruptive AI methods. In other words, are there **paradigm-changing** way of thinking about **solving physics problems if 'unlimited computational' abilities** were to be available?

- **D – Other**
  - **6.1)** Is there any other information regarding the use and potential of ML/AI in your research area that is relevant to be discussed in the task force?