# ML for NP applications

Open mic session at SANPC2024

# ML applications in NP - purpose vs. funding

https://arxiv.org/abs/2012.06582 / PLB
Show of a principle

Need for FOAs/funding addressing the *applications of ML* rather than *advancing ML*

We do not necessarily need to compete with the steep curve of development of new ML methods to advance [our] science significantly

We certainly want to apply the new developments (sometimes OLD* developments) to NP physics problems

- We are interested in explainable/interpretable ML (!) - not necessarily a target of industry (ML learning QCD splitting function)
- We are interested in a new ways of data analysis using the existing methods (e.g. recasting physics into graph NN's - jet quenching in QGP, hadronization)

Collaboration with ML-CS expertise extremely effective (again not necessarily bleeding edge ML…)

These can be a multi-purpose (cross-theory-experiment) initiatives - need for dedicated FOA's

=> more targeted FOA's (not necessarily generic ML for NP…) with the two points above in focus

*) *OLD sometimes feels like two weeks…*

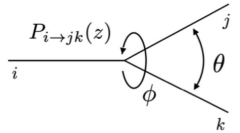
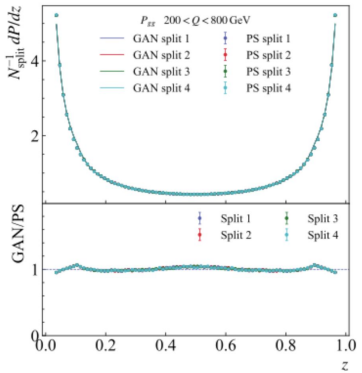



FIG. 1. Parton splitting process $i \to jk$ with longitudinal momentum fraction $z$, relative splitting angle of the two daughter partons $\theta$ and azimuthal angle $\phi$.




**ML Generative Adversarial Network learns internal workings of QCD - the Altarelli-Parisi splitting function - using information encoded in final state particle distributions.**

# Experiment (independent) co-pilot / anomaly detection - “5σ”

- Looking into infinity but perhaps not that far…

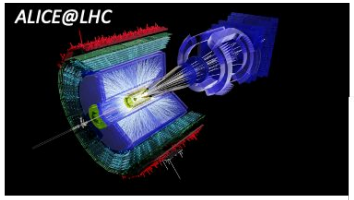
Future operations of experiments / facilities:

=> Towards ML driven automatization - “self-driving [NP] lab”

Applicable to almost “anything” (any system that produces data)

Requirements:

- Capacity to process multi-modal data
  - + engage with LLMs for simplification of communication
- Highly customizable ML workflows
  - Anomaly detection, deeper / instantaneous insight into operations based on complete information, failure prediction, optimization, …
  - Incorporate bootstrap ML mechanisms but extendable to different areas
  - Could be also used for data analysis




Radiation monitoring
- Distributed system of sensors