

AI for HEP Experimental Operations

CLARIPHY - AI Collaboration Meeting

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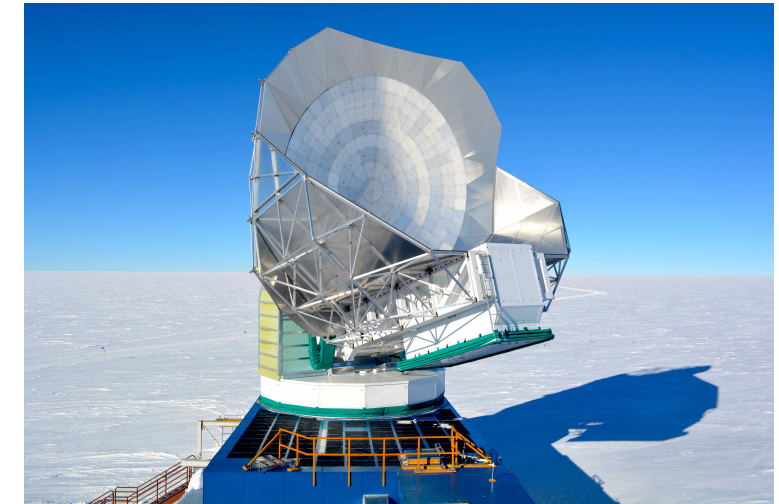
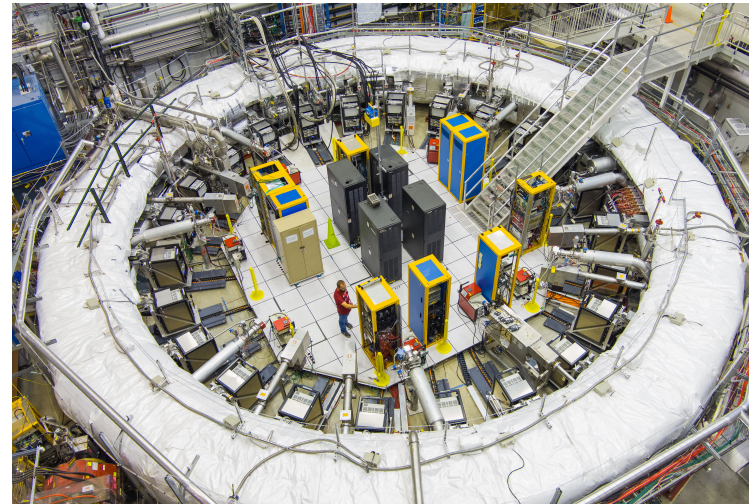
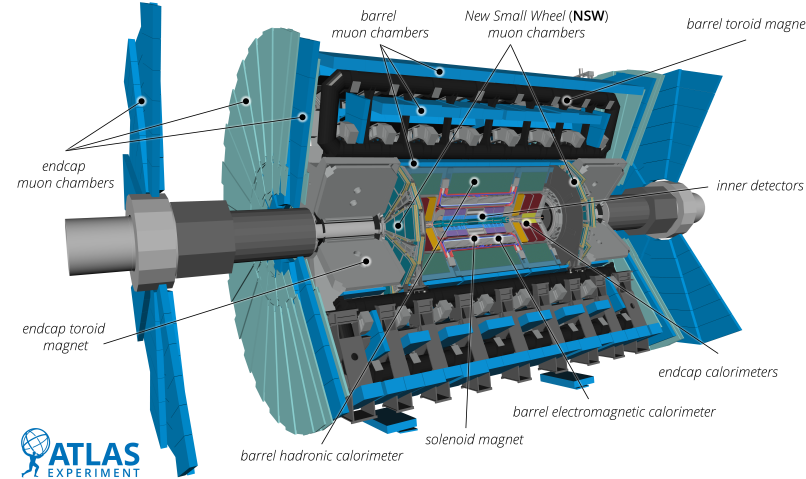


MOTIVATION: BETTER FAULT DETECTION, LESS HUMAN EFFORT

- Modern experiments produce enormous amounts of monitoring data
- Current monitoring systems include automation but require significant human effort
- Recent relevant AI/ML advances
 - Anomaly detection: we have lots of good data and don't know how future faults will look
 - Transformers: have long-term context awareness (i.e., they take past data into account)
 - Large-Language Models (LLMs): can process large bodies of documentation and logs

Opportunity to combine different fault detection models and LLMs to find subtle patterns in high-dimensional data and to suggest corrective actions

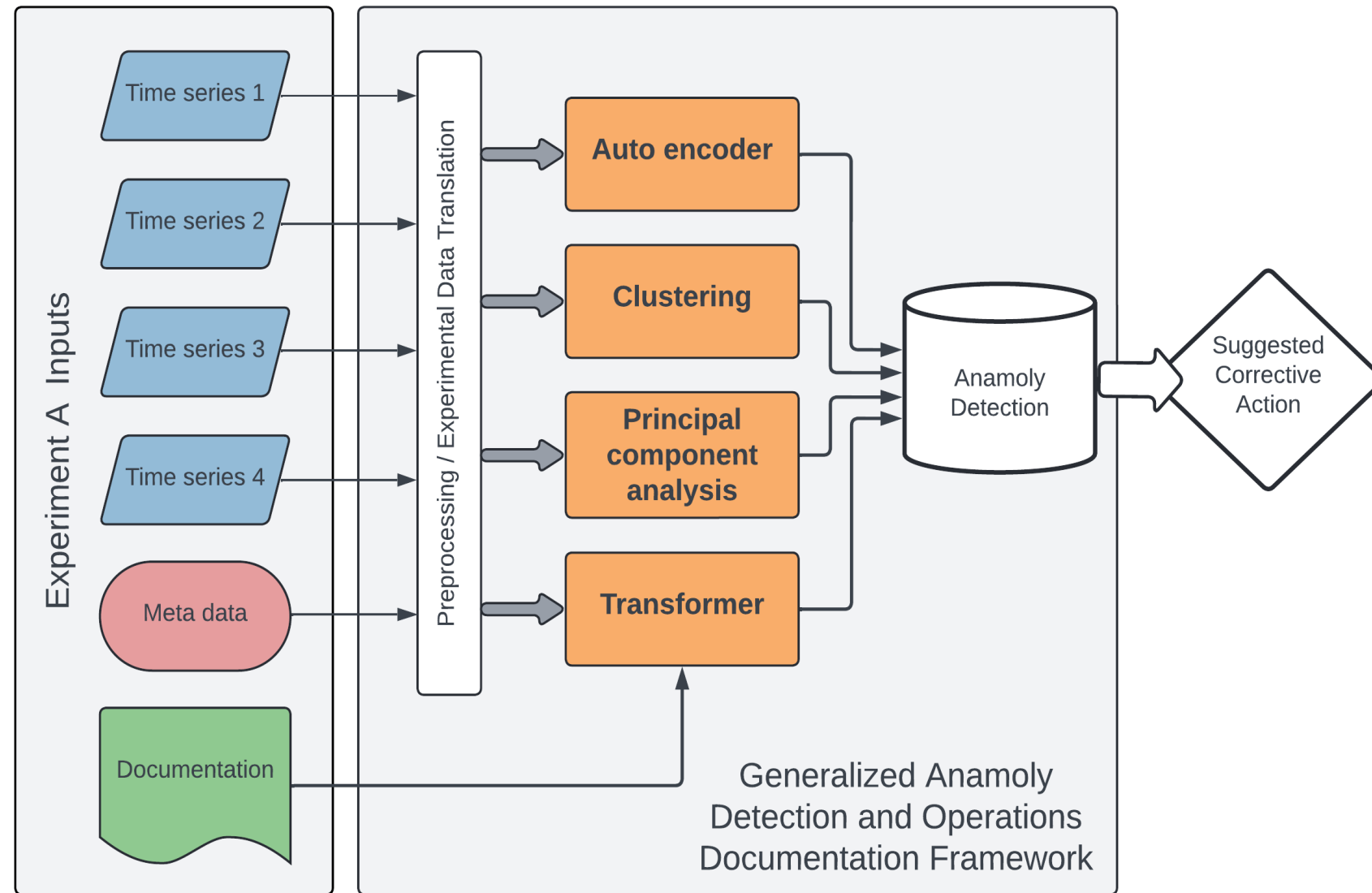
OPERATIONS ACROSS HEP EXPERIMENTS



- Many HEP experiments have similar monitoring needs
- Similar data types (time series, histograms/heat maps, logs)
- Similar workflows:
 - Detect fault
 - Find and follow troubleshooting documentation
 - Log problem
 - Potentially notify and summarize problem to expert

Develop AI methods applicable across experiments that leverages commonalities to reduce development effort and increase robustness

AI FOR OPERATIONS GENERAL APPROACH



- Modular AI/ML models for different tasks
 - Dimensionality reduction
 - Autoencoders
 - Transformer models
- Orchestration layer to combine model outputs
- LLM integration for documentation and log parsing

Building knowledge base of how to apply and combine AI/ML models to HEP operations

OPPORTUNITY FOR COLLABORATION

Already have started discussions and collaborations for Genesis proposals with several groups

- Awarded Mu2e Genesis Phase I project
- ATLAS DQM Phase I proposal (led by UT Arlington)
- ATLAS Data for operations proposal (led by UMass Amherst)
- CMS DQM proposal (led by Nebraska)
- DUNE/NOvA

Collaboration will avoid duplicate effort by sharing lessons, code, and results across experiments

GENESIS PHASE 2 THOUGHTS

- Expand with a Genesis Phase 2 to join many groups together
 - Will require careful consideration of overlap and complementarity
- More effort is needed on infrastructure and deployment of methods
 - Will require increased participation of (non-ML) operations experts to ensure operational data is available
 - Experts also need to come together to understand how to connect different information sources (e.g., how should each source be weighted?)

