IRIS Kick-off Meeting

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The University of Cincinnati and MIT

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Primary Software R&D Goals

Innovative Algorithms

Our primary **Innovative Algorithms** goals are developing algorithms and technologies to allow LHCb to fully digest the 30 MHz of data being produced by the detector in Run 3. We plan to use Machine Learning to

- to replace the most computationally expensive parts of the event pattern recognition; and
- to increase the performance of the event-classification algorithms; and
- to reduce the number of bytes persisted per event without degrading physics performance.

LHCb Innovative Algorithms Team

Name Position	IRIS Fraction	Experience, background, role
Michael Sokoloff UC Professor of Physics	small	expert in scheduling meetings and writing blather
Gowtham Atluri UC Asst. Prof. CS	50% summer	expert in AI; will supervise Ph.D. student
Kendrick Li UC Ph.D. student (CS)	full time	focus on CS aspects of ML algorithms being studied and developed
Henry Schreiner UC Post-doc (Physics)	50% IRIS	expert in software engineering and becoming an expert in machine learning
Mike Williams MIT Assoc. Prof. Physics	small	expert in ML trigger selections
Dan Craik MIT Post-doc (Physics)	50% IRIS	simulations expert transitioning to trigger work

In addition to personnel supported by IRIS, related work is being done by personnel funded through an SSE award, an NSF Graduate Fellowship, and by collaborators.

LHCb Innovative Algorithms Projects

Activity	time frame	WBS	Description
Milestone	6-12 months	4.3	demonstrate efficiency of a hybrid ML algorithm for finding primary vertices
Milestone	6 - 12 months	4.3	demonstrate efficacy of using a GAN to reduce the dimensionality of a PID autoencoder
Deliverable	12 - 24 months	4.3	provide a hybrid ML vertexing algorithm within the LHCb software stack
Deliverable	12 - 24 months	4.3	provide PID autoencoders to compress data within the LHCb software stack

Risks

The primary risks are loss of key personnel. The highest immediate risk is that Henry Schreienr may find another position within a year. As mitigation, UC is advertising the possibility of an IRIS-funded post-doctoral position. Bringing someone new up to speed on the relevant work is likely to take 3 to 6 months.

Collaborations

LHCb is moving towards creating a formal "Real-Time Analysis" project to coordinate the reconstruction, calibration, alignment, and trigger effort for Run 3. All of our reconstruction & rigger work is being coordinated with this project.

In particular, a group led by Vava Gligorov at the Universite de Paris VI is trying to move the first stage of the High Level Trigger into nVidia GPUs. We are working with personnel associated with that effort to demonstrate that an ML inference engine can be incorporated into the proposed GPU software stack.

The autoencoder work is being done in collaboration with colleagues from the Yandex School of Data Science.