

Fermi National Accelerator Laboratory

LDRD Project Data Sheet - FY19

Project ID: FNAL-LDRD-2019-017

Project title: Graph Neural Networks for Accelerating Calorimetry and Event Reconstruction

Principal investigator: Lindsey Gray

Project description: (short description and explanation of cutting edge, high-risk, high-potential science or engineering)

This project is to demonstrate machine learning using graph neural networks as a game-changing solution for imaging calorimeter data in future high energy physics (HEP) experiments. The CMS high luminosity upgrade calorimeter (HGCal) will be used as a case study. Novel algorithms using graph neural networks will be developed and evaluated using emerging specialized hardware.

Tie to Mission: (explain the project's relevance or anticipated benefits to Fermilab's and DOE's missions)

Advanced computing techniques are required to take advantage of next generation HEP detectors. In particular, there is no developed well-performing reconstruction algorithm and certainly not one that will utilize the fine segmentation represented from ~6 million channels (compared to 100K channels of the current calorimeter). It is expected that complex reconstruction can be achieved in a timely manner through the development in this project. The development will have much wider applications in HEP in determining general algorithms for improving physics performance and computing paradigms.

Previous year's accomplishments: (as applicable)

Fully-implemented physics performance, framework for extensions, and deployment on the acceleration hardware. Combined network that accurately clusters EM, hadronic, and isolated MIP signatures in the CMS HGCal. Code framework for deployment on other experiments. FPGA HLS implementation of combined network; benchmark inference on GPU and FPGA-accelerated devices on premises.

Work proposed for current fiscal year and anticipated / desired results:

With recent hire of AI associate, continue FPGA and GPU implementation and refinement, draft performance publications.

Project funding profile: (costs, budgets, projected budgets, and total)

Prior year(s) costs	FY19 ½	FY20	FY21	FY22 ½	Total
N/A	32,666	201,695	130,000	46,187	410,548

Project Start Date: 3/10/2019

Total Approved Project funds: \$ 480,905