

# 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)

Have identified networks that reconstruct tracks, photons and pions with HGCal. Have identified Fermilab resources to develop FPGA coding for GraphNN accelerators. An Azure-Edge instance is now running at FCC in collaboration with Microsoft. Initiated collaboration with LAr TPC Machine Learning teams.

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

Will begin developing multi-track reconstruction networks and work on accelerating single-particle networks that have been identified.

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

Prior year(s) costs	FY19 ½	FY20	FY21	FY22 ½	Total
N/A	32,666	227,882	150,000		410,548

Project Start Date: 3/1/2019

Total Approved Project funds: \$ 480,905