

Fermi National Accelerator Laboratory LDRD Project Data Sheet - FY19

Project ID: FNAL-LDRD-2019-027

Project title: Accelerator Control with Artificial Intelligence

Principal investigator: Gabe Perdue

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

We seek to bring artificial intelligence (AI) to the operation of Fermilab's accelerator facilities. We will pioneer the workflows and practices which are necessary for AI applications in the complex information environment of devices in the accelerator. To begin, we will apply AI to the control of Gradient Magnet Power Supply (GMPS) with a goal to achieve stability in the bend field less than 1 part in 2000.

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

Particle accelerators are enormously complex devices and their operation and tuning require constant attention from the scientists and engineers responsible for them. AI algorithms offer the potential to reduce the amount of operator time spent on demanding but low-cognition tasks and to improve the efficiency of operations overall. This endeavor has long-term potential to make a significant positive impact on accelerator operations, but we must begin conservatively - thorough safeguards to protect the accelerator complex are strictly required.

Previous year's accomplishments: (as applicable)

Data products established by building code to pull data from the Fermilab accelerator control system (ACNET) and format for first Machine Learning model prototypes. Recognized that ACNET will be too slow for the final board and we need to build the capabilities for direct access. Began test algorithms on hardware with hls4ml.

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

Establish ORC for PC "slow interface" to current control system. Evolve software tools from a Xilinx FPGA framework to an Intel FPGA framework to take advantage of AD standards. Build an offline demonstration model based on historical data.

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

Prior year(s) costs	FY19 ½	FY20	FY21	FY22 ½	Total
N/A	27,859	378,900	291,000	34,341	732,100

Project Start Date: 3/1/2019

Total Approved Project funds: \$ 732,100