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# **LSST Undergraduate Internships at Fermilab Cooperative Research and Development Agreement Final Report**

**CRADA Number: FRA-2018-0016**

**Fermilab Technical Contact: Dr. Brian Nord**

Summary Report

9 April 2021

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## Final Report for CRADA FRA-2018-0016

In accordance with Requirements set forth in Article XI.A(3) of the CRADA document, this document is the final CRADA report, including a list of Subject Inventions, to be forwarded to the Office of Science and Technical Information as part of the commitment to the public to demonstrate results of federally funded research.

**CRADA number:** FRA-2018-0016

**CRADA Title:** LSST Undergraduate Internships at Fermilab

**Parties to the Agreement:** LSST Corporation and Fermi Research Alliance, LLC

**Sponsoring DOE Program Office(s):** Office of Science – High Energy Physics

**DOE Funding Commitment Table:**

	Year 1		Year 2		Year 3		
Funding Type	Funds-in	* In-kind	Funds-in	* In-kind	Funds-in	* In-kind	Totals
Dept. of Energy	50,695		22,941		0		73,636
Totals	50,695		22,941		0		73,636

**Abstract of CRADA work:**

The LSST Data Science for Undergraduate summer internship program focuses on data-driven astronomy for undergraduates at Fermilab's Cosmic Physics Center. The internship activities focus on the development and implementation of data-driven investigatory techniques that will aid in LSST science, as well as prepare the undergraduates for future work in LSST. In particular, the internship activities include a number of opportunities for undergraduates to learn other skills critical for working on LSST --- data science research techniques, software development and engineering, science communication training.

**Summary of Research Results:**

During our previous successful LSST internship programs at the CPC, undergraduate students learned about LSST physics, astronomy, data science, software engineering, and science communication. Interns participated in hands-on, data-rich, astronomy research, working directly alongside many scientists at a diverse set of career stages (graduate students,

postdocs, senior PIs) in a vibrant, collaborative environment. The interns learned about astronomy and physics in LSST, how to use data science tools (e.g., statistics, machine learning, data visualization, high-performance computing), fundamentals of good coding practices (e.g., using GitHub and tests), and how to communicate their work and ideas to colleagues.

In particular, in the Summer of 2019, we hosted five undergraduate students from physics and astronomy. They worked in teams with each other and with local and visiting scientists to pursue LSST-relevant science analyses with machine learning algorithms --- i.e., light curve classification, strong lens detection, noise removal, and stellar stream detection. They learned about Git and used it to version and share code. They joined the full internship and visitor community to communicate the science of their projects and participate in weekly hack sessions: this means they worked under the mentorship of senior scientists, as well as provided mentorship to and engaged with high school students. They participated in communications exercises, including a course taught by the Fermilab communications Office staff about discussing science with experts and non-experts alike. All students presented their work via posters at the LSSTC Project and Community Workshop in Summer 2019 and gave presentations to the CPC scientist community before the completion of their internships.

Our candidates originate from a wide geographic base, with diversity in identity and background. In 2018, we hosted two from University of Chicago, one from Grinnell College, one from Macalester, and one from West Virginia. In 2019, we hosted six people. Both years, one of the more experienced interns worked partially as a lab manager to help facilitate activities: this person also learned more about managing science projects and research environments.

### **Related Reports, Publications, and Presentations:**

Fast Inference on FPGAs and TPUs Classifying Gravitational Lensing Images Efficiently. Christ et al., 2019.

DOI: 10.2172/1623374. FERMILAB-POSTER-2019-015-CD. (Poster presented at annual LSST PCW meeting)

Neural ODEs for Light Curves Classifying and Approximating Light Curves. Jain 2019.

DOI: 10.2172/1614721. FERMILAB-POSTER-19-106-CD. (Poster presented at annual LSST PCW meeting)

Semi-supervised learning for strong lensing analysis. Roussi 2019. (Poster presented at annual LSST PCW meeting)

Blind Denoising by Self-Supervised Neural Networks in Astronomical Datasets. Zhang et. al., 2019.

DOI: 10.2172/1614728. FERMILAB-POSTER-19-109-CD.

**Subject Inventions listing:**

N/A

**Report Date:** 9 April 2021

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