Investing in Discovery

Five Years of LSSTC's *Enabling Science* Small-Grants Program

EXECUTIVE SUMMARY. The Large Synoptic Survey Telescope (LSST) will be the flagship astronomical survey of the 2020s. To keep up with LSST's vast and complex data stream, astronomers must build strong research collaborations with concrete plans and strategies; train researchers to use modern data-science approaches; and create sophisticated analysis software.

- Since 2015, the *Enabling Science* small-grants program — made possible by a generous gift from Charles and Lisa Simonyi and Bill and Melinda Gates, and run by LSST Corporation (LSSTC) — has been the primary source of support for efforts to prepare the scientific community for LSST.

- *Enabling Science* draws on the extensive expertise at the 35 member institutions of LSSTC to direct funds to a wide range of impactful small projects.

- Our selection of the most promising, low-budget ideas proposed by the astrophysics community has engendered cost-sharing, creativity, and excellence.

- By deepening our first-hand knowledge of the critical needs of the research community, and by strengthening our relationships with key researchers, institutions, and collaborations, the *Enabling Science* program has increased LSSTC's ability to help LSST achieve its full potential.

THE POWER OF SMALL GRANTS —PROMOTING COST-EFFECTIVE INNOVATION.

Instructor Michelle Lochner giving a lesson on *A Hitchhikers Guide to Machine Learning — Applications to Supernovae Classification; "Students" engaged in discussion of questions at the* **Dark Energy School at Stony Brook***.*

Competition for modest funding awards has pushed proposing teams to innovate. For example, the *Enabling Science* undergraduate summer internships, which allow students from across the country to meet and present their research at the annual LSST Project and Community Workshop, leverages support for summer research from the National Science Foundation (NSF), the Department of Energy, and individual institutions. These organizations often target students who are underrepresented in science or are from underserved communities. Moreover, many creative projects do not fit within traditional, federal funding programs. *Enabling Science's* small grants fill this gap. Besides spreading funds to a large number of researchers, award amounts that are less than those typically distributed by the NSF are ideal for piloting potentially risky initiatives such as the LSSTC Data Science Fellowship Program (described below). To date, *Enabling Science* funds have supported **72 programs with a range of topics and formats, two thirds of which had budgets of less than $20k**.

PREPARING THE SCIENTIFIC COMMUNITY FOR LSST — STARTING STRONG. The *Enabling Science* small-grants program has an outstanding track record of impactful outcomes. To identify activities that are crucial to LSST's four key science themes[1], LSSTC issues an annual call for *Enabling Science* proposals. A rotating panel of experts selects the most promising and widely beneficial projects. With *Enabling*

---

[1] The nature of dark matter and understanding dark energy; Cataloging the solar system; Exploring the changing sky; and Milky Way structure and formation.

Science awards, many of the official LSST Science Collaborations have constructed "roadmaps" for LSST science — detailed plans for what must be accomplished between now and LSST's "first light" to make optimal use of LSST data for particular science goals. Other teams have concentrated on cross-disciplinary community building and specific data analyses. Recipients have organized "hackathon" workshops, where researchers from a variety of sub-fields work together to develop software algorithms for common LSST analysis problems, such as overlapping images of stars and galaxies, and also to create publicly available code.

> **"…I have directly witnessed the very positive impact of LSSTC support — particularly on the active engagement of junior scientists in preparing for LSST." – *Prof. Pat Burchat (Stanford)***

Enabling Science events also include high-profile conferences – a recent workshop on LSST detection of merging neutron stars generating gravitational waves attracted two Nobel laureates.

> **Without the *Enabling Science* program, "…the LSST dark matter community would simply not exist as it does today." – *Dr. Alex Drlica-Wagner (Fermilab)***

The *Enabling Science* small-grants program has significantly increased the capacity of the scientific community to utilize LSST.

A MAJOR SUCCESS: THE LSSTC DATA SCIENCE FELLOWSHIP PROGRAM (DSFP). The LSSTC Data Science Fellowship Program (DSFP; astrodatascience.org) was piloted through *Enabling Science* in 2016. The program provides six weeks of training in data-science methods to graduate students. Since 2016, DSFP has become one of the most in-demand supplemental training programs for astrophysics students, filling a major gap in traditional graduate astrophysics programs. DSFP received 486 applications for 20 slots in 2019 and has attracted enough external funds from two private foundations and the NSF to now operate independent of *Enabling Science*. However, DSFP would not exist without its start through the *Enabling Science* small-grants program.

The 2019 LSSTC Data Science Fellows: 20 graduate students from diverse backgrounds in astronomy, astrophysics, and informatics.

BUILDING ON ENABLING SCIENCE. For the past five years, the *Enabling Science* small-grants program has shown itself to be flexible and versatile in serving the evolving needs of the LSST scientific community. As the construction of LSST nears completion, the need to ready the astrophysics community to extract scientific discoveries from the enormous flow of data becomes more crucial. LSSTC is committed to providing researchers with the training, collaboration infrastructure, and analysis software they require. Our experience with the *Enabling Science* small-grants program has increased our ability to do just that. Going forward, we will build upon this experience and expand our efforts to craft novel and effective programs to maximize the scientific output and societal value of LSST.