1 (title)
Hello, and welcome. This presentation is an introduction to the Rubin Observatory's Legacy Survey of Space and Time -- the LSST -- and the ongoing process to optimize the survey strategy.

2 (Rubin)
The Vera C. Rubin Observatory is being built on Cerro Pachón in Chile, the same mountain which hosts the Gemini South and SOAR Observatories. The Rubin Observatory will house the Simonyi Survey Telescope, which has an 8.4 meter primary mirror. The LSST science camera has a 9.6 square degree field-of-view and six optical to near-infrared filters, u g r i z and y. Once construction and commissioning are complete in a few years time, the Rubin Observatory will execute the 10-year Legacy Survey of Space and Time, the LSST, an optical imaging survey of the southern sky. Both the observatory and the survey are designed to make major advances in four core science areas: dark matter and dark energy, the solar system, transients and variable stars, and the milky way and local volume. This presentation provides a basic overview of the ongoing process to choose a strategy for the LSST that will maximize science.

3 (basics)
The core science requirements that the Rubin Observatory and the LSST were designed to fulfill are described in the Science Requirements Document, which can be found online at "L S dot S T backslash S R D". The baseline survey strategy was designed to meet these core science requirements. An illustration of the current baseline survey strategy, also called the version 2 baseline, is shown here as a map of the sky, with regions colored by the number of visits received over ten years. The wide-fast-deep survey of extragalactic regions, a total of at least eighteen thousand square degrees, would receive about eight hundred visits in total, over all filters, in ten years. Within the wide-fast-deep region, there is also a requirement that all fields observed in a given night must be revisited in that same night to enable the discovery of moving objects. The baseline survey strategy includes additional areas as shown in the sky map: at least five deep drilling fields, the north ecliptic spur, the galactic plane, the south celestial pole, and the virgo cluster. This baseline survey is a fiducial strategy which will achieve the core science requirements, but there remain many open questions about how to optimize the strategy to maximize the scientific return of the LSST.

4 (open questions)
Here we list a few examples of open questions about the wide-fast-deep survey. The first is the wide-fast-deep footprint, in other words, how the wide-fast-deep area should be defined. For example, whether and where to apply limitations based on galactic latitude or Milky Way extinction. Second is the wide-fast-deep cadence. The term cadence refers to how often fields are revisited, both within a given night and in between nights: the intra-night and inter-night cadences. Third on this list is the optimal filter distribution for wide-fast-deep fields. The quality of photometric redshift estimates, for example, can be sensitive to the combination of depths in the six filters. Fourth here we mention the opportunity to obtain colors of moving or variable objects by doing the intra-night revisit in different filters. These types of questions about filter distribution and cadence for the wide-fast-deep regions also apply to the deep drilling fields and

mini-survey areas. In addition, there remain open questions about how frequently gravitational wave target-of-opportunity observations could be executed with the Rubin Observatory without risk to the core science goals of the LSST.

5 (OpSim terminology)
To help the science community address these open questions, the Rubin Observatory LSST Scheduler Team is generating a wide variety of simulated surveys. These are called Operations Simulations, or OpSim runs for short. Each OpSim run takes as input strategy parameters such as area and revisit frequency, generates 10 years of site data such as weather, and then schedules 10 years of observations. The result is an OpSim database of simulated observational metadata. To help scientists evaluate these OpSim runs, the LSST Scheduler Team built the Metric Analysis Framework, or MAF, a code package that enables the derivation of scientific results from an OpSim database. An individual metric is a measure of scientific performance, such as the number of detections of a type of object, or the 10-year coadded depth in an extragalactic field. The LSST Scheduler Team has so far generated over 100 different OpSim runs, and the science community is actively designing metrics to represent a wide variety of LSST science goals and engaging in comparative analyses of the various survey strategies.

6 (rubin-sim)
Anyone interested in creating science metrics to evaluate OpSim databases should use the rubin_sim package, which includes tools to analyze the simulated survey strategies. More information about the package can be found in GitHub or in its documentation, and there are tutorials available to teach you how to use it. The recommendation is to use rubin_sim in the NOIRLab Astro DataLab. Launch a Jupyter Notebook in the DataLab, use a terminal to git clone the rubin sim notebooks repository, and then start with the notebook labeled 00 using the provided kernel. The rubin sim package is already installed at the Astro DataLab, and the tutorial notebooks will run so long as you choose the kernel named LSST 2021.10.13 Py3. If you have any questions or encounter any issues, please post them in the Survey Strategy category of the Rubin Community Forum using the link in the footer of this slide, where the Rubin Survey Scheduler team will see it and be able to help you out.

6 (process)
In order to progress towards a decision about the LSST strategy, the Survey Cadence and Optimization Committee -- the S C O C -- was formed in 2020. This committee consists of ten individuals representing the LSST science community, and will stand for the duration of the Rubin Observatory operations. The S C O C is charged to recommend specific survey cadences for the commissioning phase, for early science in the first year, and for the full 10-year survey. The S C O C is changed to consider input from both the LSST science community, including the Science Collaborations, and from Rubin Observatory staff, in particular the Survey Evaluation Working Group. The Survey Cadence and Optimization Committee requested input from the science community in the form of cadence notes about their metric analyses of the OpSim runs in early 2021. The S C O C used these cadence notes to produce their Phase 1

Recommendations for the baseline survey strategy in late 2021, and will continue to evaluate community input through 2022.

7 (Bianco et al.)
If you're interested to learn more about the process to optimize the LSST survey strategy, check out this paper by Bianco et al. titled "Optimization of the Observing Cadence for the Rubin Observatory Legacy Survey of Space and Time: a pioneering process of community-focused experimental design". It is the introductory paper of an ApJ Focus Issue on LSST cadence and survey strategy.

8 (cadence notes)
All of the cadence notes submitted by the science community are listed on this website. There are about 40 of them, and they are all publicly available to read.

9 (recommendations)
The phase one recommendations from the S C O C are part of their work towards a final recommendation for the baseline survey strategy for the LSST. These phase one recommendations represent a combination of changes in response to the Cadence Notes and earlier simulations, and identification of areas that need further investigation before they can make their final recommendations.

These phase one recommendations include a small shift in the overall survey footprint, increasing the amount of low-dust-extinction sky included in the wide-fast-deep area, and adding wide-fast-deep coverage in the Galactic Bulge. The general wide-fast-deep footprint remains bounded by declination limits, but now has additional dust-extinction considerations.

While visits will, in most bandpasses, continue to consist of two back-to-back 15-second exposures, also referred two as two "snaps", in u band the visits will be a single exposure of 30-seconds. During commissioning, this recommendation will be revisited, as there is considerable preference for moving towards single 30-second exposures in all bands, if possible, for a higher-efficiency survey.

The SCOC found that the pair of visits in each night should be split between two different filters, for better color measurements of transients and variables, but requested further evaluation of the overall number of visits within a night and the timing of these visits.

A two-band "rolling cadence" has been adopted throughout the low-dust wide-fast-deep region, but this is still an area of ongoing investigation. Further evaluation is necessary and a rolling cadence task force is being assembled to study this in more depth.

Finally, there are many options for focused special surveys such as micro-surveys requiring less than about 3% of the overall survey time. These include options like Target of Opportunity programs. The SCOC has directed further investigation into the potential costs or benefits of including these special surveys in the overall survey strategy.

The S C O C’s phase 1 report is available in full at P S T N dash 0 5 3 dot LSST dot IO.

10 (timeline)
This slide has the timeline for future S C O C activities. In 2022, new simulations of the Phase 1 recommendation for the baseline strategy will be produced by the Rubin survey scheduler team. After community input the S C O C will produce a draft of their Phase 2 recommendations, and there will be a survey strategy workshop in the summer. By the end of 2022, new simulations of the Phase 2 recommendation for the baseline strategy will be produced. It is expected that the adopted initial baseline strategy for the LSST will be fixed and implemented in early 2023, with any additional modification made by the end of 2023.

12 (summary)
If you have any further questions about Rubin Observatory, there are a variety of ways to find answers. First, please come to the Vera C. Rubin Observatory booth in the Winter 2022 AAS exhibit hall, where we would be happy to answer your questions. Second, please feel welcome to visit our online community forum, at Community.lsst.org. This is the best place to seek answers for questions about the LSST. In particular, in the Science category there is a Survey Strategy sub-category full of announcements and discussions related to cadence optimization. The contents of our forum are publicly available to search and read, and anyone may obtain an account in order to post questions or participate in discussions. There are a couple of additional resources related to the LSST cadence provided in the side-bar of this slide as well.

Third, if you’re interested in getting involved in preparing for science with Rubin Observatory, you might like to join one of the eight LSST Science Collaborations. The Science Collaborations are independent, worldwide communities of scientists, self-organized into collaborations based on research interests and expertise. They are laying the groundwork necessary to prepare for doing science with the LSST data products and services, and are open and welcoming to all, especially to students. Joining a Science Collaboration is a great way to learn about Rubin Observatory.

Goodbye and thanks for watching!