A goal of the LSST project is to capture the optical sky into a database so effectively that observing the database is a satisfactory, and even superior, substitute for individual observations. Such data set a deep, high-quality, time- and color-sampled image that will enable a wide variety of science. A large part of reaching this goal is designing a smart and adaptive strategy for scheduling observations, one which can effectively merge multiple requirements into a single program of observations while maximizing time on the sky and coping efficiently with changing conditions in real time. Diverse requirements include multiband imaging of 30,000 square degrees of sky, achieving a uniform depth of exposure across 20,000 square degrees in each of six filters, allowing effective search strategies for NEOs and short- and long-period variables, and providing frequent, deep exposures to characterize faint transients and moving objects. We present results from detailed simulations of LSST operations which include time-dependent descriptions of site conditions and a sophisticated model for the operations of camera, telescope, dome, and data system. We describe current progress in the LSST scheduler design and present recent simulations of prototype ten-year LSST missions which demonstrate that all of the science requirements and constraints can be accommodated successfully into a single survey.

**LSST Scheduling Goals**

In a ten-year survey, the LSST will take more than five million exposures, collecting over 60 petabytes of raw image data. Processed in real time, these data will form a deep, exquisite-calibrated, time-dependent, multi-color movie of 30,000 square degrees of sky. Capturing such a rich photographic record, and making it readily available, will enable a broad array of scientific investigations to be carried out in parallel by "observing" the database rather than directly observing the sky.

The sequence, or cadence, in which these exposures are made is essential to achieving multiple scientific goals from a single survey. The algorithm which embodies this sequence will be the "brains" of the robotic observatory. We have developed a sophisticated operations simulator for LSST to aid in designing this algorithm. It allows us to explore what science the survey can enable in practice. It provides a detailed connection between scientific requirements and specific elements of the system design. By running sample surveys with given scheduling criteria, we produce simulated catalogs which contain complete information about the observations performed, time, position, sky backgrounds, transparency, and detailed information on telescope configuration. These sample surveys are then analyzed with respect to their success in reaching a wide variety of scientific goals, frequently by coupling them to models of specific astronomical systems and the appropriate analysis pipelines. In this way we can assess the impact of cadence modifications with the greatest possible fidelity.

The LSST survey sequence must provide:

- Time and color sampling to detect and characterize a wide variety of transient, cadence modifications with the greatest possible fidelity.
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- Uniform exposure of a large area of sky to enable an accurate catalog of photometric redshifts.
- For each position on the sky, a wide range in position angle of the telescope pupil on the sky and the camera angle on the pupil to control photometric and shear systematics.
- The highest possible image signal to noise ratio by obtaining images at the lowest airmass and sky backgrounds consistent with other survey goals.

**Cadence Design**

LSST will take data as a sequence of short exposures at a single position on the sky and in a single filter called a "visit." Typically, a visit is two back-to-back 15-second exposures separated by two seconds to read out the focal plane array. Designing the LSST survey requires ordering these visits in time and allocating them among its six filters so as to maximize the return on scientific goals in a fixed survey duration. Cosmological parameter estimation by many techniques requires uniform coverage of 20,000 square degrees of sky and obtaining accurate photometric redshifts with a specified number of visits in each filter; shears measurements benefit by allocating times of best seeing to observations in the r and i bands. Maximizing signal to noise ratios requires choosing the next filter based upon the current sky background. Supernova cosmology requires frequent, deep photometry in all bands, with z and y observations even during dark time. Detecting the motion of solar system objects and transients, characterizing variability on various timescales, and acquiring the best possible photometric and parallaxes places further demands upon the distribution of revisit intervals and observation geometries to each point on the sky. Finally, making uniform progress toward these goals facilitates analyses made while the survey is still in progress.

Making the most effective use of a fixed survey duration requires adopting different survey strategies in different parts of the sky. The effect of changing airmass on sky transparency can be substantial in the LSST survey area. The LSST survey area is divided into four regions:

1. **Bands**
   - r, i, z, y, j, and zy bands
   - The highest possible image signal to noise ratio by obtaining images at the lowest airmass and sky backgrounds consistent with other survey goals.

2. **Visit Duration**
   - 30 seconds
   - 30 minutes

3. **Number of Visits**
   - 30
   - 300
   - 3000
   - 30

4. **Exposure Uniformity**
   - Increasing exposure uniformly: The example surveys shown above, and in the upper panel of this figure, employed a fixed set of field centers which were visited repeatedly. The lower panel shows the result of obtaining the field locations systematically throughout the course of the survey, distributing the extra exposure obtained in field overlap regions smoothly across the sky. The red regions are those receiving 10 minutes of exposure per night.