Efficient use of the data produced by the Large Synoptic Survey Telescope (LSST) will require comprehensive a priori knowledge of the impact of telescope design and implementation on the resulting catalogs and images. This includes gross characteristics like per band detection limits (coadded and single frame), as well as fine grain information such as point spread function behavior as a function of focal plane position and limits on the ability of the imaging system and reduction pipelines to accurately map galaxy shapes. The LSST Image Simulation group is leading the effort to simulate the LSST system from end-to-end with high fidelity. Input catalogs include source variability, moving objects, and cosmological transients are matched to the LSST survey depth of r=28. These catalogs can be used to produce simulated images for exercising the data reduction pipelines as well as simulated catalogs for calibration, moving object detection, and probing proposed science questions. We present the progress toward end-to-end simulation of the LSST system.

**Milky Way Model**

The model of the Galaxy is based on the model by Juri et al. (2005) and includes thin disk, thick disk, bulge, and halo components. In addition to the stellar distribution model, the simulated stars are embedded in a galactic dust model formed from Amon and Lepine (2005) dust maps. The plot in the top right shows the density of stars as a function of equatorial coordinates. The black dots are the locations of the planets.

**Galaxy Model**

The galaxies are distributed based on the Millennium simulation using light cone software from the N-body shop at the University of Washington. Physical properties were derived from semi-analytic models of De Lucia et al. (2006). Galaxies have disk, bulge, and AGN components each with an extinction model and SED. The figure to the left shows the density of particles in the Millennium simulation. We use a four degree radius light cone to populate the base catalogs.

**Solar System**

The solar system model is based on the model presented in Grav et al. (2010). Since the astrometric precision must be good to 10 mas, great care is taken to enable accurate calculation of ephemerides quickly. 10 million individual orbits are realized on one day intervals resulting in > 1 billion database entries for 1 year. The figures to the right show the different solar system groups that make up the model. The black dots are the locations of the planets.

**Variable Sources**

LSST will catalog more periodic, transient, and moving sources than any single survey has done to date. Thus it is particularly important to be able to simulate the variable sky to high fidelity. We include periodic sources through single band light curves. Where known, we can include full spectrot-temporal variability. For example, see the average type Ia supernova variability surface to the left (SALT: Guy (2005)). Capabilities for simulating stochastic variability including stellar flares and AGN variability are in place.

**Simulated Images**

Catalogs are generated with the properties appropriate to an observation under the conditions predicted by the OpSim. These catalogs are then used as input to the image simulator. This can be repeated to build large sections of the survey that can be used in testing endeavors. The simulated images are one of the major products for testing the system. The images provide input for completing scaling tests, I/O tests, and other data management tasks. They also provide a set of truth images for evaluating algorithmic challenges.

**Simulated Catalogs**

Shown above is a plot of the number of calibration stars in a patch of sky the size of a single 0.2 X 0.2 LSST CCD. Along with simulated images, simulated catalogs like the one shown above are very useful for testing certain aspects of the LSST system. In circumstances where simulating images is either prohibitive because of compute time or unnecessary from an algorithmic standpoint, catalogs that simulate observations may be just as helpful as images for testing purposes. A single set of simulated catalogs is not sufficient for all testing purposes. Each test requires that a different set of effects are included. For example, reference catalogs should represent mean apparent brightness and position, whereas source catalogs will contain cloud obscuration, differential chromatic refraction, and proper motion.

**Examples of simulated catalogs:**
- Calibration catalogs—For testing calibration solution algorithms
- Reference catalogs—Provide true values for object properties and astrometric and photometric solution algorithms
- Input for moving object pipelines—Simulated source detection for testing moving object detection
- Science catalogs—Mimic outputs of full data reduction pipelines for community scientists to practice with.

**Future efforts will focus on improving all areas of the testing framework. Specifically, work is under way to improve the base models by including more stellar populations, improving variability models, and including more realistic galaxy spatial models.**

The interface structure is also being improved to supply simulated images and catalogs in near real time.