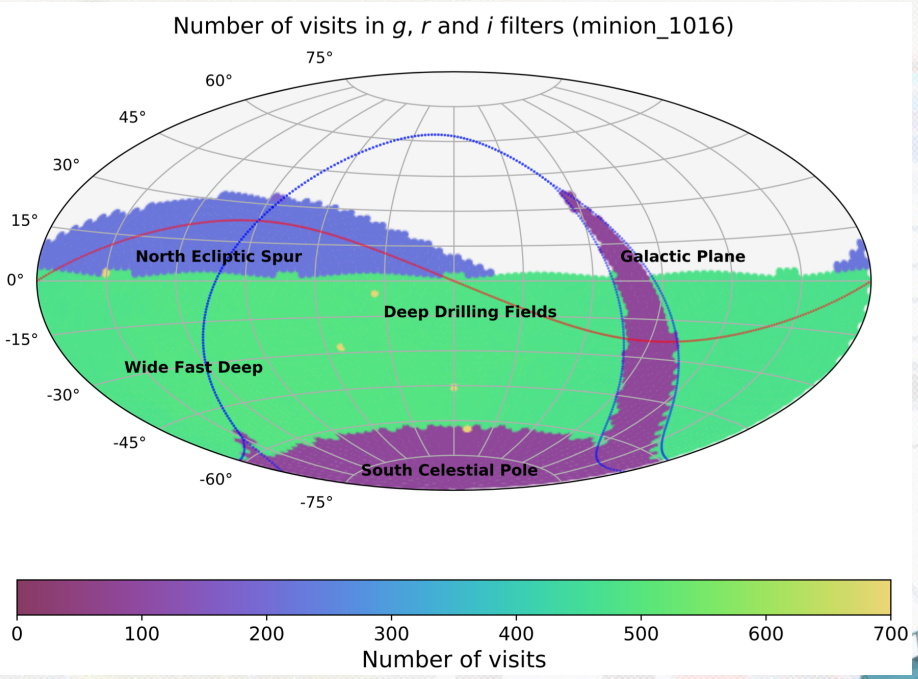
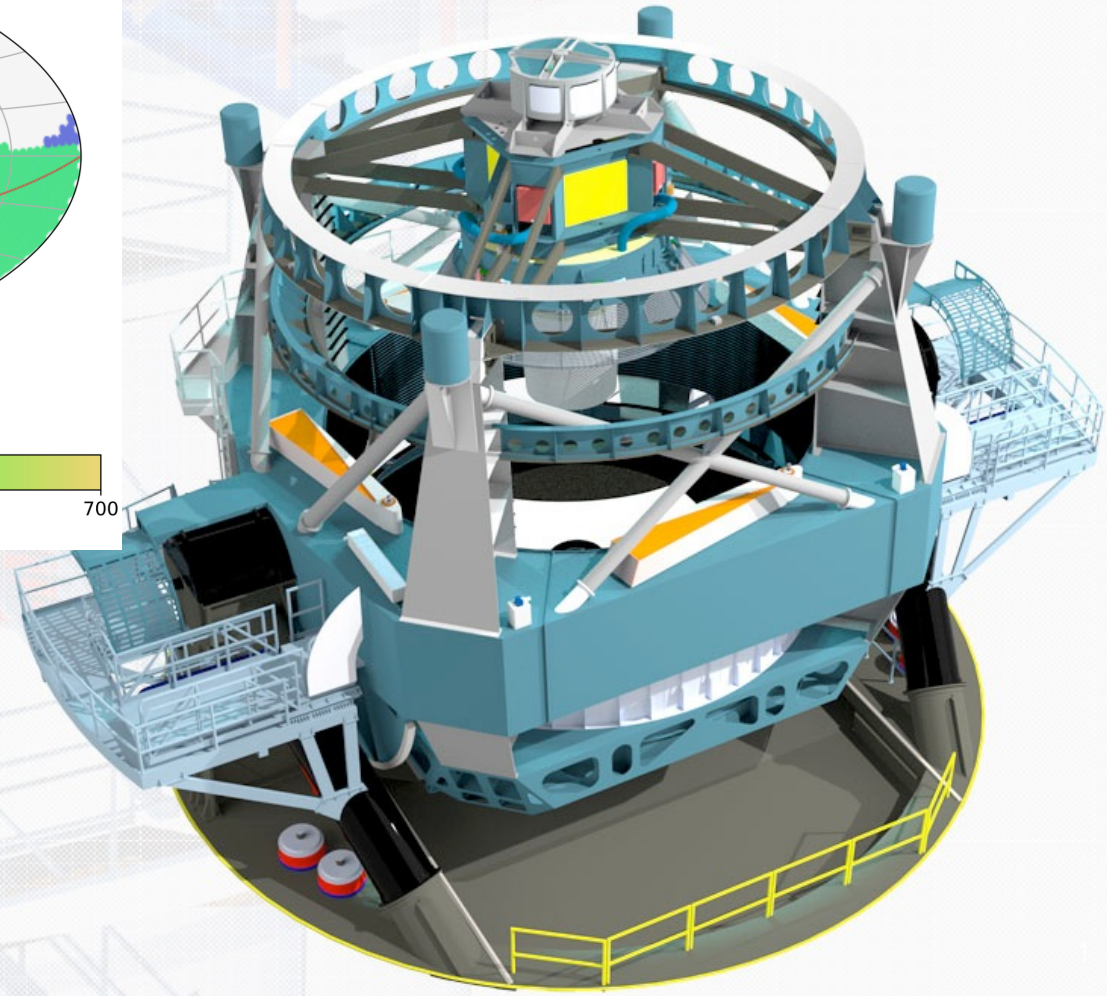
Plans for Observing Strategies and Cadence Optimization

Željko Ivezić & LSST Simulations and Scheduler Teams

SAC @ LSST 2017 all-hands meeting

Aug 14, 2017





LSST SAC Meeting, March 5, 2017

The SAC is excited about the release of Version 4 of the Operations Simulator. In this context:

- We recommend that the formal definitions of the boundaries of the Wide-Fast-Deep survey be re-examined with the tools available with the OpSim.
- We recommend that the OpSim code be made available to the community to carry out their own experiments in survey design.

The SAC endorses the plan and timeline presented to us for engaging the community in further developing the plans for deep drilling fields. We recommend that these plans be expanded to examine the currently planned mini-surveys, as well as ideas for additional such surveys and observing modes.

The scientific goals and the parameters for the currently planned mini-surveys need to be re-examined.

The call for white papers on additional survey modes should go out only after a reasonable set of Version 4 OpSim runs have been performed, analyzed, and written up for the community. In addition, they should have a clear statement of process, including strict timelines and a description of the review and decision-making process. The project should consider having public events such as Town Halls at the AAS meeting to describe the process and bring it to closure.

Outline

1) Brief status update

- SOCS/Scheduler Development Schedule
- Observing Strategy white paper: lessons learned
- improvements in organization and new resources

2) What are we planning to do over the next 3 years (~ until commissioning starts)

- plans for cadence optimization program
- open questions for considerations by the community

SOCS/Scheduler Development

- SOCS/Scheduler v1.0 (aka OpSim4) beta released in Feb 2017; OpSim4 validation has not been completed yet.

- v1.0 supports rolling cadence (and fixes a number of earlier problems, e.g. the so-called “western bias”)

- for detailed SOCS/Scheduler development plan (old dates but release content is [still] correct), see

http://ls.st/7qv

- SOCS/Scheduler v2.2 (the last release) released by the end of 2020 (NB the release schedule might be revised)

- SOCS/Scheduler release schedule drives in part the cadence optimization program

Lessons learned from "The ten cadence questions"

LSST Observing Strategy White Paper considers **a large number of LSST science cases** that cover all major science themes to provide guidelines for improving baseline LSST cadence (~300 pages by ~100 authors).

In order to standardize various constraints derived from diverse science cases, **ten questions about cadence were formulated** and provided to all authors.

Detailed answers were provided for 20 major science cases; 76 answers provided actionable input.

Conclusions derived from those answers are listed in a document provided to the SAC, and are only briefly summarized here.

Lessons learned from "The ten cadence questions"

1)The Project should implement, analyze and optimize the **rolling cadence** idea (driven by supernovae, asteroids, short timescale variability).

2) The Project should execute a **systematic effort** to further improve the ultimate LSST cadence strategy (e.g. sky coverage optimization, u band depth, special surveys, DDFs).

The LSST Observing Strategy community and the white paper effort provided exceedingly useful guidance about cadence to the Project (many thanks to Phil Marshall for his leadership!)

While **baseline cadence** meets the basic science requirements for the LSST survey, we know that it **can be meaningfully improved!**

In part as a result of these recommendations, the Project decided to reorganize and re-energize the cadence optimization efforts:

1) Three new hires for the Scheduler development (Tiago Ribeiro, Colin Winslow, Andrew Heyer), led by Francisco Delgado.

2) A new dedicated postdoc (Owen Boberg) to work with Lynne Jones, Kem Cook and Zeljko Ivezic on cadence optimization (including interactions with the community).

The role of the SAC and community in advising the Project on cadence-related decisions

1. We need to define quantitative science drivers for the observing strategy of the LSST (e.g. the depth and filters required for early science; the sky region, cadence and number of filters required to “measure something”).
   The SRD is intentionally vague on these details!

For example, is 10% of observing time dedicated only to deep-drilling programs or to all non-WDF programs (e.g. Galactic plane)?

Per SRD, 90% of the total time goes for WFD, and 10% for everything else. If the system will perform better than expected, or if science priorities will change over time, it’s conceivable that 90% could be modified and become as low as 80%. But at this time, it’s 90% for WFD and 10% for everything else, as codified in the SRD.

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2. To express these drivers in terms of “metrics” by which the science returns (simulated surveys) can be quantified

3. To define the (OpSim) experiments needed to develop and test these metrics so that we can determine how much science is gained or lost as a function of the current survey strategy or future modified strategies

The role of the SAC and community in advising the Project on cadence-related decisions

Example questions that are hard to answer ("SAC will do it!"):

1. Quantitative science drivers:

   - an example: the proposal to extend WFD survey to the Galactic plane (Gould, A. 2013, arXiv:1304.3455)

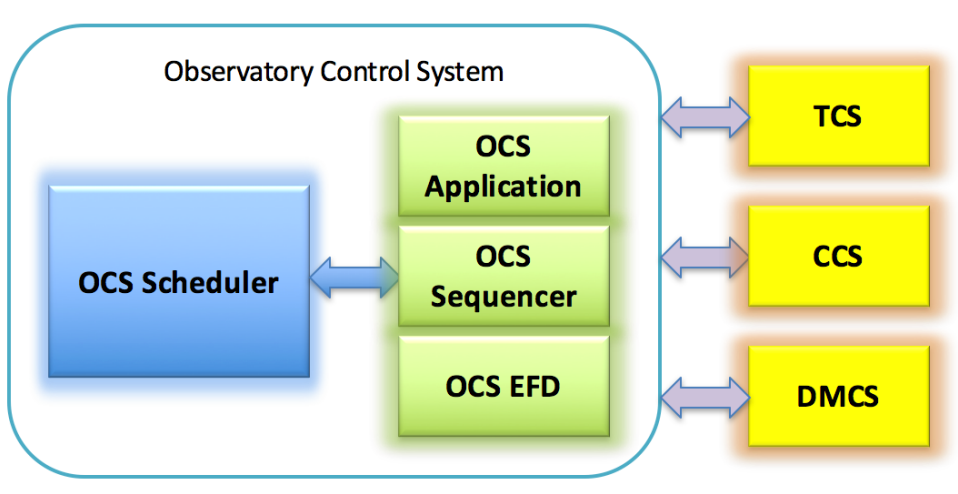
   Is the anticipated science worth 10% of LSST?

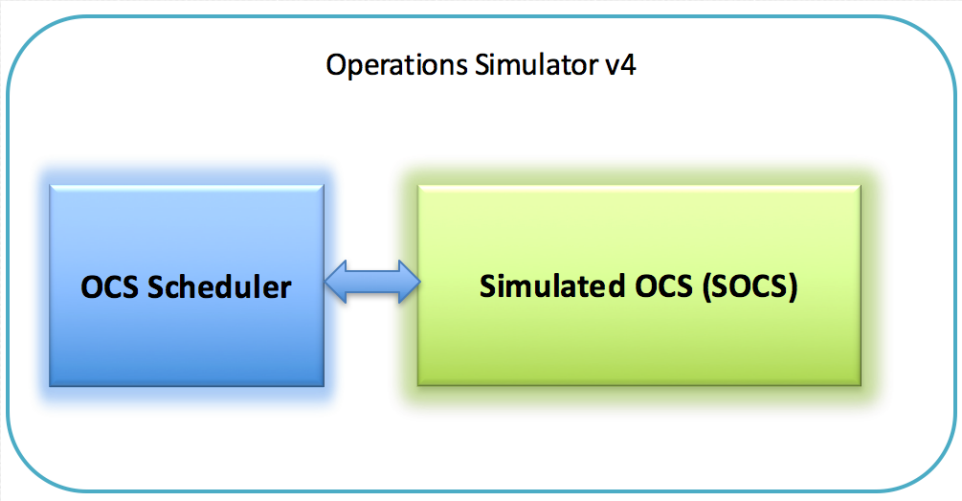
2. Metrics:

   - an example: how does a 10% improvement in "early SNe" metric compare to a 10% improvement in proper motion metric?

3. OpSim experiments: we don't have infinite resources; for example, which X% of proposed modifications shall we study?

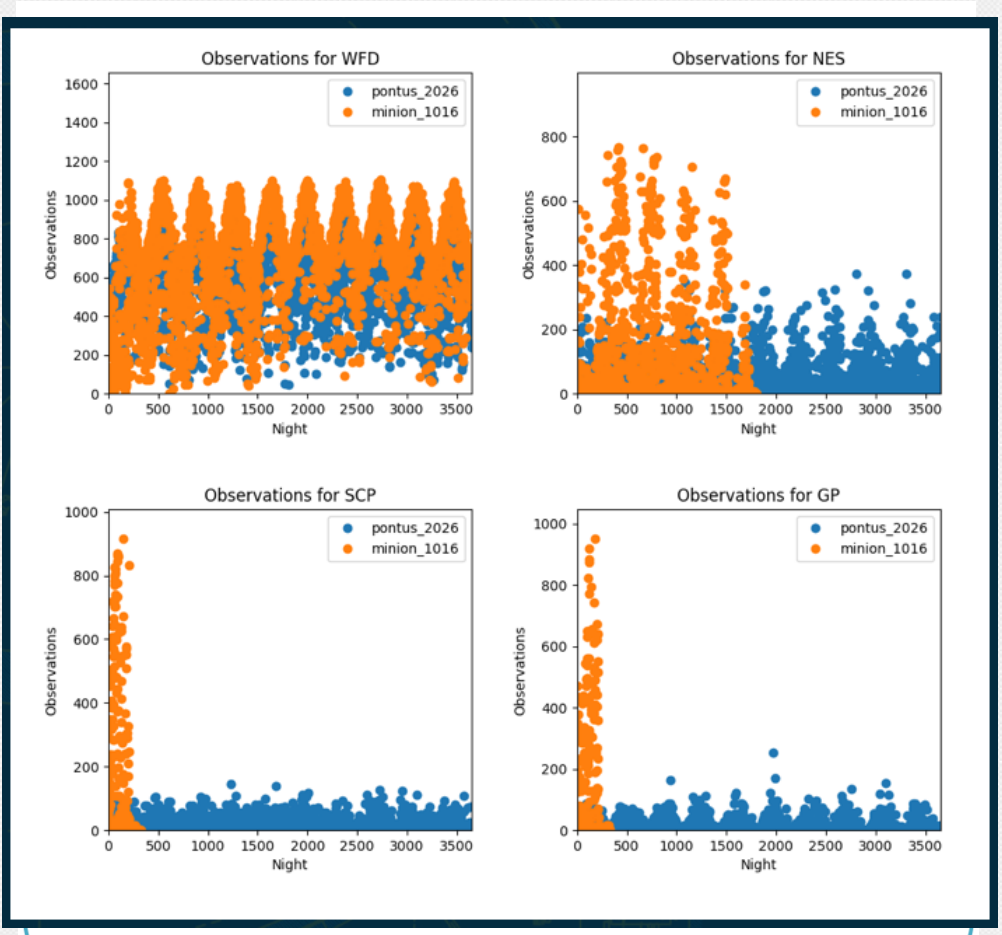
Plans for the cadence optimization program





- the piece of code that drives OpSim, called **the Scheduler**, will also be a part of the Observatory Control System: T&S deliverable

Plans for the cadence optimization program



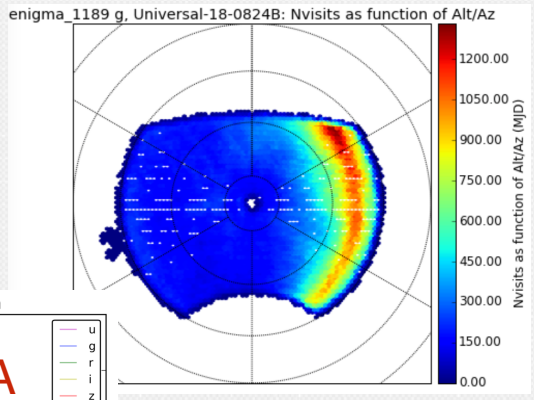
- the piece of code that drives OpSim, called **the Scheduler**, will also be a part of the Observatory Control System: T&S deliverable
- the Scheduler v1.0, which is part of OpSim4, was just released:

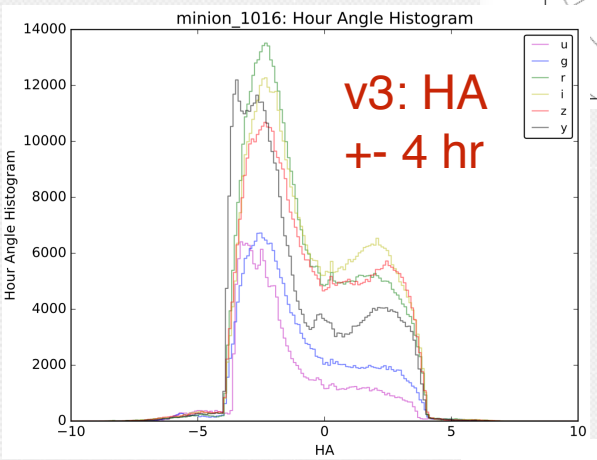
Main improvements v4 vs. v3:

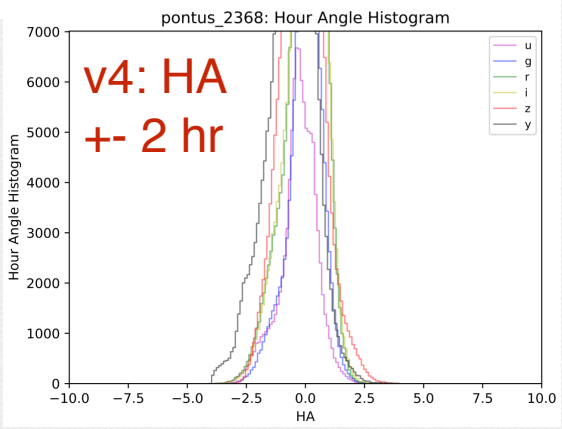
- Better time uniformity
- Repeatability over full 10 year survey with same configuration
- Sky region selection using coordinate cuts
- New sky brightness model (ESO, includes twilight)
- Separate instances of Observatory model for SOCS and Scheduler
- Configuration Parameter User Interface

Plans for the cadence optimization program

v4 fixed the "western bias" problem:







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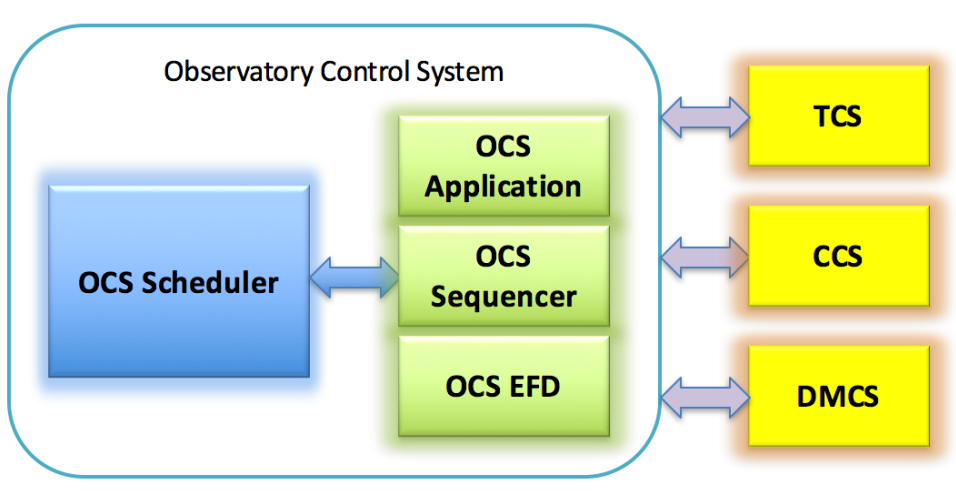

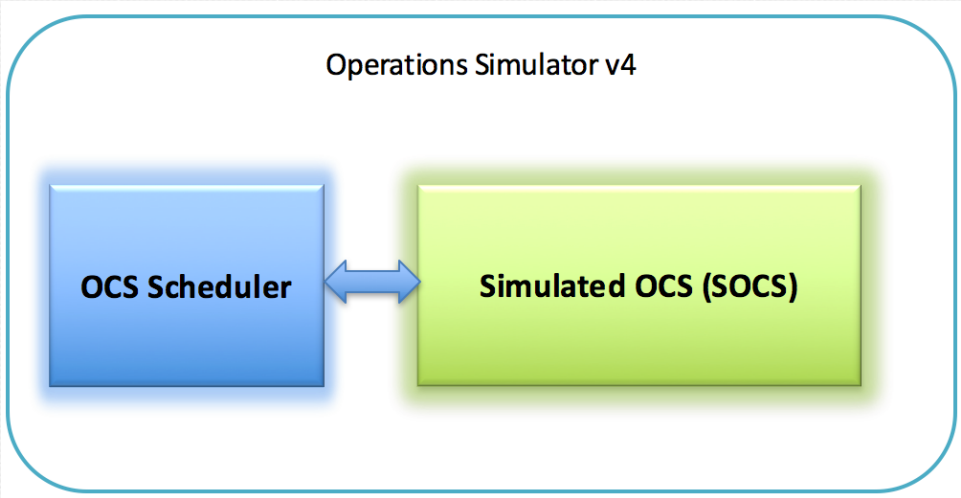

- the piece of code that drives OpSim, called **the Scheduler**, will also be a part of the Observatory Control System: T&S deliverable
- the Scheduler v1.0, which is part of OpSim4, was just released
- in addition to numerous bug fixes and improvements, it now enables simulations of **rolling cadence**
- another eagerly anticipated version is v1.2 (by mid 2018): it will deliver the so-called "look ahead" feature (will a field set before the pair is completed?)
- the last release, v2.2, expected in early 2021, will enable other scheduling algorithms

Plans for cadence optimization program

- separation of 1) SW (software) engineering and delivery of the Scheduler code by the T&S Scheduler team from 2) interaction with the community and cadence optimization efforts under Project Office

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- development of the code by the T&S team can be adapted to new requirements or findings in the process of interaction with the community; to address that posibility the project has a Change Request **process** in which the proposed changes are evaluated in cost and schedule and may be eventually incorporated as changes in the release plan (presented below)

Plans for cadence optimization program

- separation of 1) SW engineering and delivery of the Scheduler code by the T&S Scheduler team from 2) interaction with the community and cadence optimization efforts under Project Office

- three **logical** phases for the cadence optimization program

  1) develop tools (running OpSim at scale & MAF improvements) that will enable production and analysis of hundreds of simulated cadences

  2) interact with the community and stakeholders:

  - **call for DDF white papers: Dec 2017 (due Apr 2018)**
  - **call for mini-surveys white papers: Oct 2018 (due Feb 2019)**

  and finalize the definitions of cadences for WFD, DDF and mini-survey programs

  3) produce, analyze and document a judiciously chosen series of cadences and present to the SAC for a final strategy recommendation (by May 2020)

Important: we anticipate many iterative interactions towards convergence with the community rather than a requirements-to-deliverable model.

Schedule for Cadence Optimization (July '17)

	Cadence Optimization	Calls to Community
2017	Start work on tools to run MAF & Opsim at scale	
	Rolling cadence experiments; DDF experiments/examples	Publish Observing Strategy white paper (OSWP) Call for DDF white papers (Dec)
2018	Rolling cadence experiments evaluated with OSWP metrics; Mini-survey experiments/examples	DDF white papers due (Apr)
	DDF WP -> simulated surveys; mini-survey experiments	Call for mini-survey (special programs) white papers (Oct)
2019	Updated baseline with DDF + rolling cadence (June)	Mini-survey white papers due (Feb) Request for white paper and metrics update (Mar)
	Mini-survey WP -> simulated surveys;	White paper with metrics due (Aug)
2020	Finalize MAF and Opsim tools; deliver documentation and a series of simulated surveys to SAC; form SSC	
	Ask SAC and Survey Strategy Committee to recommend the initial observing strategy	
2021	Announce initial survey strategy and publish a baseline simulation that reproduces that strategy	

Recommended means for providing input about LSST cadence

- the LSST Science Advisory Council (SAC) is the main mechanism for officially collecting and delivering community input to the Project. All strategic and political issues should be communicated via SAC (Michael Strauss)
- the Observing Strategy white paper is the main mechanism for providing scientific input about cadence
- to enable an open and archived discussion, we will setup a “category” on community.lsst.org
- for concrete cadence modification proposals, please use the form at http://ls.st/smg
- the LSST Project Scientist is responsible for cadence optimization efforts and is the formal liaison between the community and the LSST Scheduler/OpSim teams (chairs PST and reports directly to the LSST Director); please feel free to email with any questions you might have (ivezic at astro.washington.edu)

SAC, community.lsst.org, white paper, webform and the LSST Project Scientist

Summary

1) OpSim4 (Scheduler v1.0) was recently released and it now supports the "rolling cadence" strategy (needs validation)

2) The 2017 community-led Observing Strategy white paper provided exceedingly useful guidance to the Project

3) The Project has identified new resources to undertake a cadence optimization program over the next 3 years

4) The community will play a major role in this program

5) The Science Advisory Committee will be asked to make an informed recommendation for the final observing strategy

6) The Project invites your input via: Obs.Strategy white paper, SAC, cadence webform, community.lsst and Zeljko