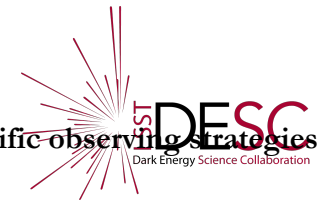# *LSST Observing Strategy*
Status and plan (SN point of view)

Ph.Gris & N.Regnault
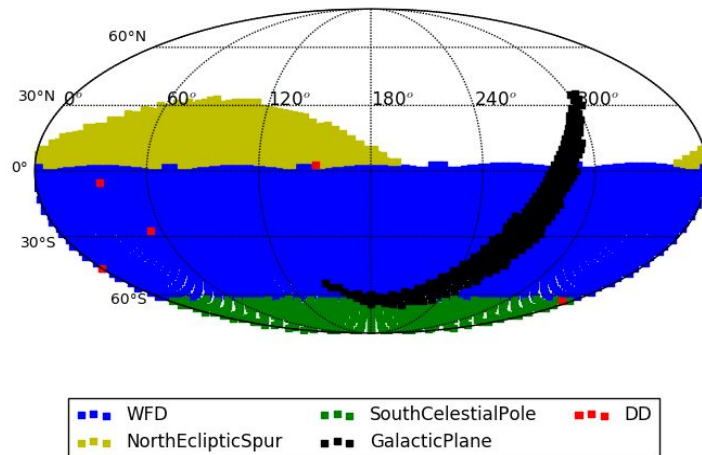
LSSTF-SN meeting
2019/06/04

Latest events

- **June 2018:** call for white papers giving science cases that LSST could address and suggesting specific observing strategies to optimize that science
- **November 30, 2018:** 46 papers received
- **In DESC:** effort coordinated inside the Observing Strategy Task Force (OSTF) (M.Lochner, D.Scolnic). Two white papers released:
  - **WFD (Lochner et al):** *Optimizing the LSST Observing Strategy for Dark Energy Science: DESC Recommendations for the Wide-Fast-Deep Survey.*
  - **DDF (Scolnic et al):** *Optimizing the LSST Observing Strategy for Dark Energy Science: DESC Recommendations for the Deep Drilling fields and other Special Programs.*

  A (DESC) journal article with more details about the metrics will be published soon.

- The LSST Science Advisory Committee (SAC) was charged with recommending simulations based on these (46) white papers.
- These simulations will be used as input for making decisions on the LSST observing strategy.
- Supposed to be an iterative process: OpSim team will make simulations available to the LSST science community and the results will inform decisions about refined simulation experiments.
- OpSim runs announced on **https://community.lsst.org/c/sci/survey-strategy**
- SAC report: *A Report from the LSST Science Advisory Committee: Recommendations for Operations Simulator Experiments Based on Submitted Cadence Optimization White Papers (April 2019)*

SAC Recommendations - WFD

- **Footprint suggestions**
  - **Original footprint: $-62° \leq \delta \leq +2°$, cut at low Galactic latitudes**
  - **Original footprint, no low Galactic latitude cuts**
  - **$-72° \leq \delta \leq +12°$, cut at low Galactic latitudes**
  - **$-72° \leq \delta \leq +12°$, cut in Galactic extinction E(B-V) < 0.15**

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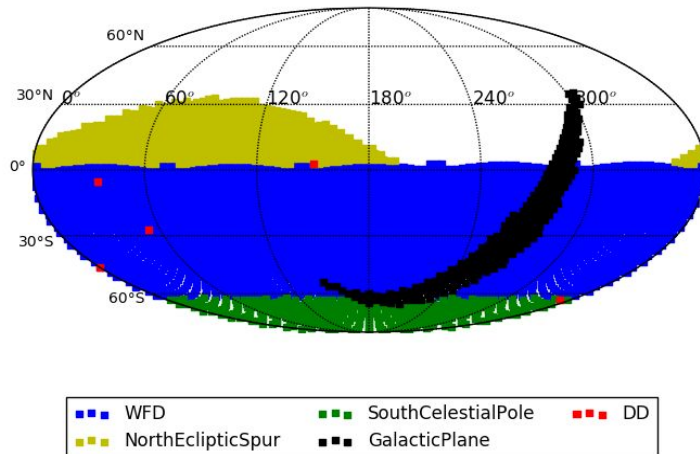
SN: 😐 increasing footprint area is great provided the cadence is not (strongly) affected

SAC Recommendations - WFD

- **Cadence**
  - **Goal: minimal coverage of 825 visits per field, summed over the six filters**
  - *Two modes for the simulation*
    - **Reaching minimal coverage and devote remaining time to mini-surveys, DDF, and others**
    - **Setting a firm limit (~ 10%) for all ancillary programs, and maximizing the total visits or depth in WFD.**
  - *Exposures and visits*

**LSST visits :
30 sec on the sky**

Current default : 2x15s	1 snap of 30s
read-noise limited (u-band under dark sky)	~ 7% gain of telescope time

Final decision: as-delivered performance of the camera, instrument and image processing software.

SAC recommendation as default

- **Shorter exposures (1s and 5s) to extend LSST photometric system to brighter magnitudes**
  - **observations of the entire LSST footprint with 1s (twilight) and 5s exposures in all 6 filters**
  - **LSST footprint covered with 1s exposures and 5s exposures (twice for each)**
  - **Experiment to have u-band exposures longer than 30s**
- **Adjust exposure time of a given visit to give uniform depth: exposures in cloudy conditions with a bright sky, high airmass and poor seeing would have visits longer than 30s.**

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SN: 😐 **increasing telescope time is great but saturation effects are also more important @very-low z.**

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SAC Recommendations - WFD

- **Choices of fields and filters per night and per month**
  - **Repeat visits** required to measure, for instance, proper motion/parallax vectors of solar system asteroids
  - Pair of visits adequate to measure tracklets, distinguish asteroids from transients and artifacts, …
  - *SAC suggestions for repeat exposures*

1) No restriction on the filters of second visit	**3)** If first visit in r: second visit in r as well (maximizes sensitivity to faint red Kuiper-Belt Objects). Each field should be revisited at least six times in a given season.
	If first visit in the g band, second visit in i. A repeat observation (same field) in g the following night.
2) second visit forced to be in a different filter from the first visit	**4)** "Presto-Color" scenario: pairs of visits within 0.5 hour in a pair of filters (ideally g&i or r&z), followed by another obs in one of those filters later in the night.

- No strong requests for repeat observations in u or y.
- u-band observations should be concentrated ±2 days of New Moon: y-band would be swapped into the filter wheel for the rest of the month. Observations in y: when the moon is up, as well as during twilight.

7

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SAC Recommendations - WFD

- **Rolling Cadence**
  - In the current baseline cadence, the time between visits in a given filter is often of the order of 2 weeks
  - A number of white papers "argued strongly" that a more rapid cadence is needed, using the "rolling cadence"
  - Suggested scenarios

Universal cadence

Rolling cadence

Two-equal halves	**Three-parts**	**Six-parts**
- each half in alternate, plus modest coverage over the remaining footprint - 1rst and last years full footprint	• Roll between 1.5 and 7.5 years (full-footprint otherwise) • 1,5,9,10: full-footprint; roll ⅓ otherwise	• Roll 6 years (1.5-7.5) • Remaining time: full footprint

- **Season length**
  - Current implementation of OpSim maximizes the season length given airmass restrictions
  - Would be useful to run a rolling with extra weights to extend observing season length

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😐 **impact on cadence?**

SAC Recommendations - DD

- **Dithering**
- **Cadence : only two proposals retained**

Long seasons (more than 6 months)

- **"Rolling cadence":**
  - **gri and zy interweaved every 3 days**
  - **2,4,8,25,4 visits in grizy**
  - **No recommendation for u-band**
- **Expected budget: ~ 6.2%**

DESC

- **ugrizy observations every two days**
  - **4,1,1,3,5,4 visits in grizy**
  - **u-band: important for active galactic science**
- **Expected budget: ~3.4%**

AGN

**SAC suggestion: "hybridized" DDF program:
AGN some years, DESC others.**

- **Location**
  - **4DDFs already committed:**
    - **COSMOS, XMM-LSS, ELAIS-S1, CDFS**
  - **One additional DDF (synergy with EUCLID)**
    - α, δ = 04:44:00, -53:20:00
  - **5 additional DDFs requested by Solar System Science**
    - **(ecliptic longitude, high galactic latitude)**

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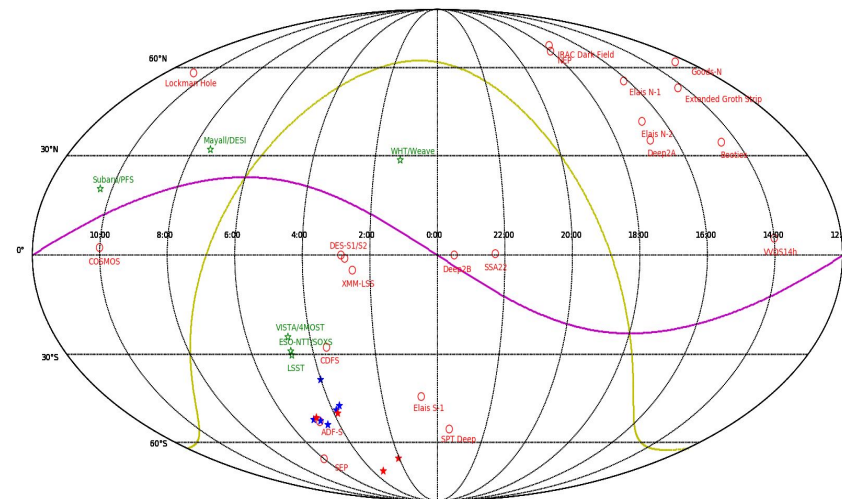 - **u-band: important for active galactic science**
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Survey strategy assessments

- A set of metrics has been setup to assess observing strategies:
  - Number of well-sampled supernovae
  - redshift limits (per band)
  - detection rates (per band)

$N_{SN}(z<zmed)$

z_{med}

# Survey strategy assessments

- **Some of these metrics are available in the Metric Analysis Framework (MAF) and are run with the bundle of metrics (OpSim team)**
  - **https://github.com/lsst/sims_maf/tree/master/python/lsst/sims/maf/metrics -> metrics**
  - **https://github.com/LSST-nonproject/sims_maf_contrib/tree/master/science/Transients -> notebooks**

- **Additional metrics have been included in the supernova pipeline (Survey Strategy Support pipeline)**
  - **To install/run the pipeline see https://github.com/LSSTDESC/sn_pipe/tree/dev_stable**

Survey strategy assessment

cadence

5-sigma depth
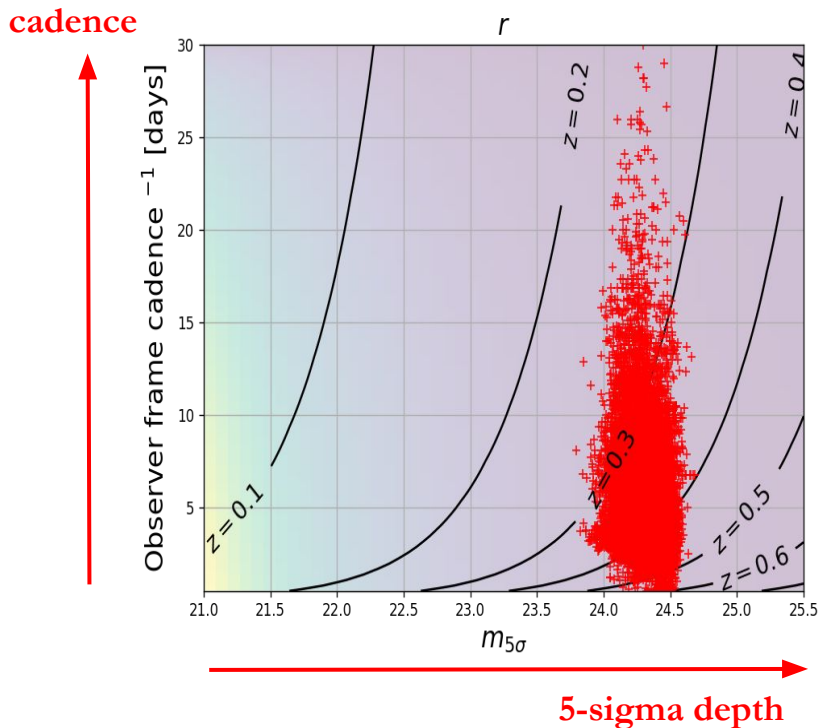
Detection rate   **r band**

z_{lim}
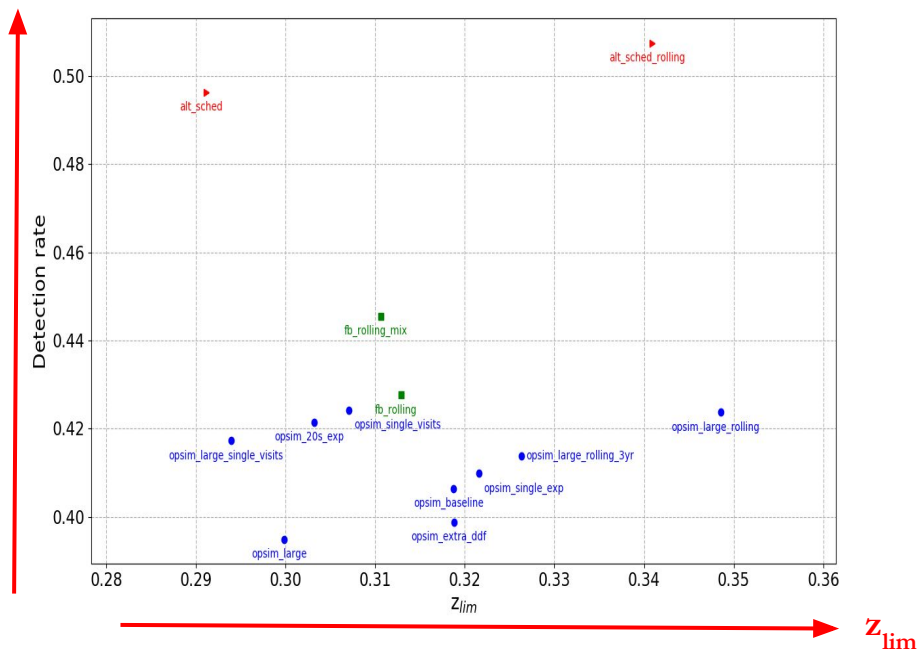
- All these metrics will be run using the new strategies as input.
- More to be added: early classification, photometric classification, FoM, peculiar velocity, …