

LSST @ Europe 2

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Workshop

Local Volume, Stars, Planets, Solar System

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Goals and discussion topics

Workshop goals

- discuss new and/or further develop LSST science cases
- discuss the impact of LSST baseline observing strategy for specific science cases
- Science Cases developed by Science Collaborations (see Lucianne talk)
- Science cases collected in the Science book
- Cadence Optimization simulation cases in a specific document : [ls.st/o5k](https://lsst.org/lsst/o5k)

Examples-I

- science verification cases and mini-surveys

- 10% of time on mini-surveys
- M67 mini-survey (rotation, stellar activity...)
- Magellanic Clouds
- Galactic plane
- 3 on Solar System Objects (mini-moons, NEOs in twilight, meter-size impactors)

- Cases for short exposure surveys (from 5 to 0.1 sec)

- Bright stars
- Short time scale variability

- Cases for deep drilling surveys . Now 4 fields selected at high Galactic latitude. More cases will be selected in the future

Examples-II

■ Specific science cases which might have an impact on the cadence requirements

- Migration in the Galactic disk / bulge science case
- Rare stellar types
- Variables/transients

Periodic Variable Type	Examples of target science	Amplitude	Timescale
RR Lyrae	Galactic structure, distance ladder, RR Lyrae properties	large	day
Cepheids	Distance ladder, cepheid properties	large	day
Long Period Variables	Distance ladder, LPV properties	large	weeks
Short period pulsators	Instability strip, white dwarf interior properties, evolution	small	min
Periodic binaries	Eclipses, physical properties of stars, distances, ages, evolution, apsidal precession, mass transfer induced period changes, Applegate effect	small	hr-day
Rotational Modulation	Gyrochronology, stellar activity	small	days
Young stellar populations	Star and planet formation, accretion physics	small	min-days

Examples III

- Relations with other surveys not yet (fully) explored
 - Auxiliary data needs
 - Critical cases missing in other surveys
- Critical areas where specific needs are identified
 - Star/galaxies separation
- Modelling: galaxy (bulge kinematics..), stars

Follow-up

- Much can be learned by adopting a broad-scoped approach, in which ground facilities look at the same target with different wavelengths, timescales and technologies. Such an approach requires resources and coordination
- IAU Executive Committee just created a new WG Global Coordination of ground and space astrophysics
- Where Europe can contribute
- Coordinate actions
- What are the needs? Static vs transient follow-up
- How could it be organized?

Science case proposals

Solar System Objects

■ **Near simultaneous colour information (M. Granvik)**

- requires repeated exposures in different filters on the same field.
- suggestion of small-survey proposal.
- Mario brought up the idea of requiring the last few tens of fields to be reimaged every time a filter is changed. This should provide at least some near-simultaneous colour data.
- Simulations of this observing strategy are required to determine how well this will work

Science verification-I

- **Bulge inner region (G. Bono, see slides)**
 - Only LSST can survey it on large areas using mainly y , z band
 - RRLyrae (faint mag. due to high extinction) → variability detection
 - Faint Cepheids beyond the Galactic center → variability detection
 - Photometric quality in crowded fields
 - Reddening determination
 - Comparison with other data (DECAM)
 - Immediate science outcome on Galactic Structure (bulge, disk flaring)

Science Verification-II

- **Globular Clusters /Halo field stars** (Bono see slides)
 - GC Proper motions useful to address the issue of accreted vs in situ halo formation
 - Main sequence bending at 0.4 Mo in u band due to opacity effects; visible in (g-u) at about 3mag below the turnoff
 - mag difference with TO → age indicator
 - Usefully applied also to field population for age determination
 - useful to disentangle galaxies-stars
 - Testing photometry/ astrometry in crowded regions
 - Strategy: sufficient number of observations in u to probe the halo

Short exposure science cases

■ **Rapidly rotating solar system objects (Granvik)**

- Fast cadence for occultations (W. Fraser)

- requires shorted $< \sim 2$ s exposure times

- requires repeated exposures on the same field (duration to be determined)

- effective cadence to be determined by camera thermal behaviour. A commissioning proposal to determine this already submitted.

- Interaction with the galaxies people to see if their fast-cadence image requirements can't be satisfied by us, and vice-versa

- The occultation rates for various asteroid/TNO populations should be quantified

■ **Focused survey on bright stars to link to Kepler/K2 data (Szabo see slides)**—also important for science verification

- Targets: Globulars, open clusters, bulge, galaxies (IC1613, Leo IV)

- Light curves down to 18-20 mag

- Important for variability detection, and cadence verification (stars with spots, RR Lyrae, eclipsing variable, short period stars...), and classification L3 products

- Useful for magn calibration from bright to faint end linking to other surveys (typical case transients)

Cadence

■ Galactic Plan survey (G. Bono)

- Plan 10% of the time maybe not adequate to discover and study Mira and C stars (periods from 100 d to years)

■ Variable stars (L. Eyer)

- Address the problem of period aliasing using simulations
- Periodic objects allows to work in the phase diagram applying methods typical of simultaneous observations such as PCA
- When the phase is not conserved the sampling is critical (i.e spotted stars, cool stars)
- Simulations could be useful to assess the impact on gyrochronology studies

Miscellaneous

■ Simulations/modelling needs

- Galaxy model down to faint magnitudes
- to be updated using constraints from Gaia and other surveys (although at brighter mag)
- asteroid collision

■ Auxiliary data: no need identified beside Gaia and WD

■ Follow-up

- Rapid alert required for flare stars, SN (pre-outburst phase)
- Feedback from follow-up campaigns to be taken into account in (yearly) cadence reviews.
- Observation organization is a task for the Science Collaborations
- The number of alerts requires a specific observation strategy inside LSST Consortium, but also inside the scientific community at large