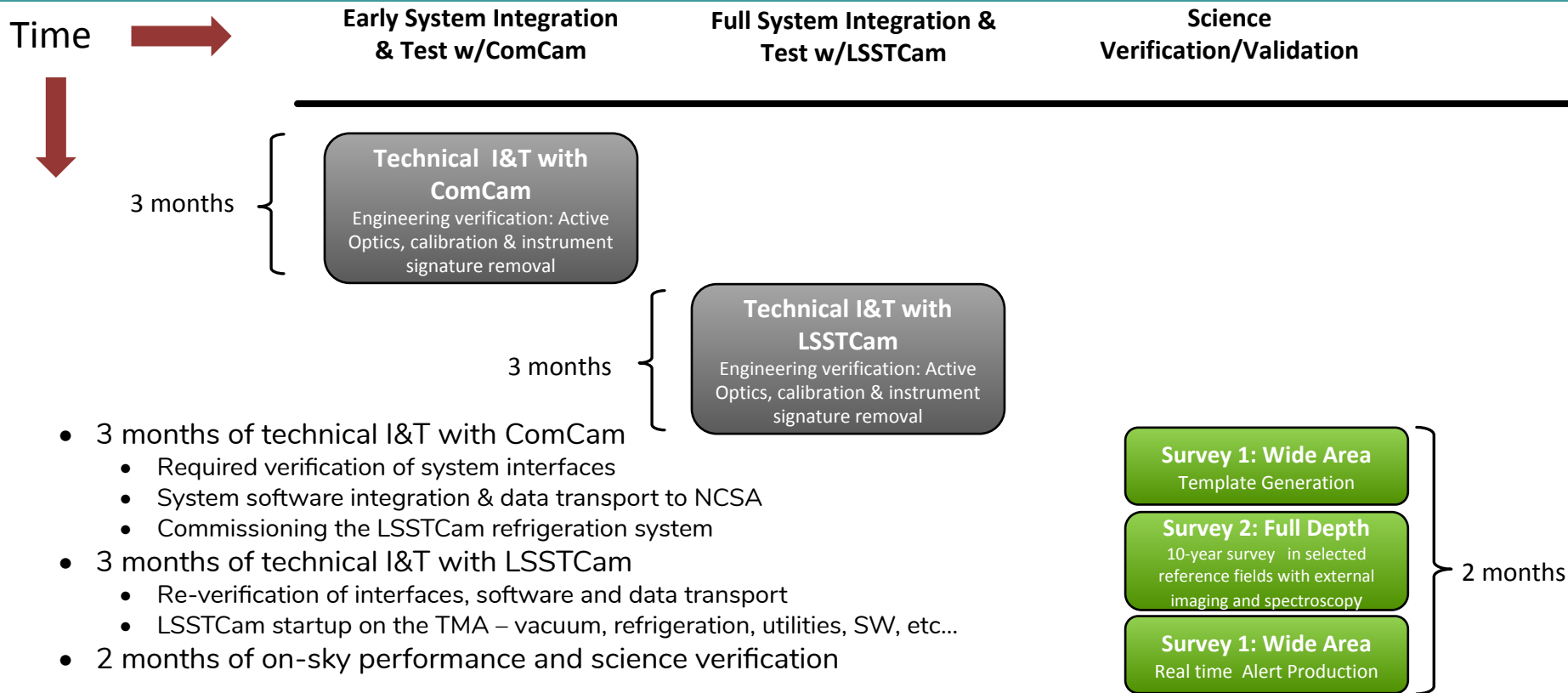# What do we mean by "Early Science"

- Early Science is any science enabled prior to the first data release, DR1.

- DR1 is scheduled for release for 12 months after the start of operations (and based on the first 6 months of data),

- Expectations of early science have been built on the basis of substantial science verification and validation surveys, and data previews coming out of commissioning (Rubin PCW2019).

- We have also informal guidance from NSF to ensure early science is evident (i.e. year 1).

Current On-sky Observing Schedule

Time ➡

Early System Integration & Test w/ComCam

Full System Integration & Test w/LSSTCam

Science Verification/Validation

3 months {

Technical I&T with ComCam
Engineering verification: Active Optics, calibration & instrument signature removal

3 months {

Technical I&T with LSSTCam
Engineering verification: Active Optics, calibration & instrument signature removal

Survey 1: Wide Area
Template Generation

Survey 2: Full Depth
10-year survey in selected reference fields with external imaging and spectroscopy

Survey 1: Wide Area
Real time Alert Production

} 2 months

- 3 months of technical I&T with ComCam
  - Required verification of system interfaces
  - System software integration & data transport to NCSA
  - Commissioning the LSSTCam refrigeration system
- 3 months of technical I&T with LSSTCam
  - Re-verification of interfaces, software and data transport
  - LSSTCam startup on the TMA – vacuum, refrigeration, utilities, SW, etc…
- 2 months of on-sky performance and science verification

From: Commissioning Science Verification Session, Bechtol & Claver

2020 October 30

Current Commissioning Data Expectations

Phases of planned on-sky data collection:

- ## ComCam and LSSTCam Integration and Test
  - Expect to deliver modest amounts of science-quality imaging (e.g., few hours to few nights)

- ## Science Verification Surveys (example "minimal" plan)
  - Single-visit Performance:
    - 6 star flats in *ugrizy* * 4 epochs = 4 nights
  - Nominal observing for scheduler testing = 3 nights
  - Challenging regions = 1 night
  - Full-Depth Survey:
    - 20-year depth in *ugrizy* overlapping at least 1 external reference field, allowing multiple dither tests (factor ~3) → ~5K visits = 8 nights
  - Wide-Area Survey:
    - 800 deg^2 in *griz* filters to 1-year equivalent depth, repeated in two phases → ~12K visits = 20 nights

From: Commissioning Science Verification Session, Bechtol & Claver

Ensuring Early Science

Rubin Operations Team is developing a plan to ensure Early Science based around three possible scenarios:

1. Commissioning goes well but there is little template generation in SV. The system is "ops ready" but templates from commissioning and SV surveys do not cover the full sky nor in all filters.

2. Hugely successful commissioning and SV, with huge amounts of templates generated before year 1.

3. There is still commissioning work work left to do in year 1 for full operations readiness, which would constrain any early science and also the ability to generate lots of templates.

Early Science with minimal SV surveys

- A ~3/6 month "campaign for early science" is a possibility

  - Non-survey activity could delay DR1 and must be reconciled with survey cadence 10-yr science goals.

- What is the best use of time in this period?

  - Align early science as closely as possible with regular survey operations
  - Time domain science enabled by incremental template generation (do SV survey 1?)
  - Provide catalogs (e.g. Magellanic Clouds, DDFs, and other calibration fields)
  - What is needed for cosmology and galaxies?
  - Peer review for one month of community proposals

Strategy for Alert Production in year one

- The DM Science team (DM-SST), recently carried out a study, of several options for Alert Production in Year 1, reported in DMTN-107: Options for Alert Production in LSST Operations Year 1.

- Representatives of the LSST-PST, DM-SST and Operations reviewed the proposed DM-SST options at a meeting in October, 2019 and converged on a proposed strategy for Alerts in year 1:

  - ***Commissioning – Data Templates***: Build templates, where possible, from all commissioning data before the start of year one, and use them to generate alerts during year one.

  - ***Year One – Data Templates***: Build templates progressively from data obtained during year one (e.g., on a monthly timescale), and use them to generate alerts during year one, either instead of, or in addition to using commissioning data to build templates.

Constructing templates outside DRP during year one

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- [LCR-2273](#): Construct Image Differencing Templates Outside DRP

  - -- 1.4.6 Template Coadds ID: DMS-REQ-0280
    The DMS shall periodically create Template Images in each of the u,g,r,i,z,y passbands. Templates may be constructed as part of executing the Data Release Production payload, *or by a separate execution of the Template Generation payload. Prior to their availability from Data Releases these coadds shall be created incrementally when sufficient data passing relevant quality criteria is available.* -- Accepted   DM Baseline Change!

- To enable artifact rejection, templates will be built with at least three images in year one, and five in subsequent years. (*Rubin OSS-REQ-0158*)

- Once a template is produced for a sky position and filter it will not be replaced until the next Data Release to avoid repeated baseline changes.

- Templates are not necessarily built from the first N images that are collected.

Implications for year 1 cadence

What does incremental alert generation capability and SV/commissioning template generation imply for cadence of year 1?

- Science collaborations have started to publish research notes highlighting early science opportunities in year 1 based on detections in difference images and the requirements on templates (e.g maximize area vs noisier difference images.)

- Different cadences/filters will favour different science; need to run simulations and present the possibilities to stakeholders; choices will need to be made.

- If the year 1 cadence is different, we need to understand the impact on the 10-yr science goals of the survey.

Coordination of Early Science

- Working with the Survey Cadence Optimization Committee (SCOC) and Science Advisory Committee (SAC) to coordinate the Early Science and the initial survey cadence.

- SCOC recommendations on Early Science will be considered by Operations Director.

Charge To The Survey Cadence Optimization Committee (SCOC)

The Purpose of the SCOC

The SCOC is advisory to the Rubin Observatory Operations Director (currently Bob Blum). It will begin its work in 2020, and will be a standing committee throughout the life of Rubin Observatory operations.

Its tasks are as follows:

- Based on input from the OpSim team and the Vera C. Rubin Observatory Legacy Survery of Space and Time (LSST) Science Collaborations, make specific recommendations for the cadence choices for the full 10-year survey. These recommendations will include a description of the pros and cons of the various choices, and will be in the form of one or more reports which will be made public.
- Help communicate these recommendations to the science community through, for example, posts on community.lsst.org and reports to the LSST Science Collaborations.
- Based on the plans for commissioning, and the realized performance of the telescope and software, make specific recommendations for "Early Science" observations, to be carried out at the end of commissioning and the first months of Rubin Observatory operations.
- During operations, receive reports from the Survey Evaluation Working Group (SEWG), a project-internal group of scientists that will evaluate the current and expected performance of the survey and scheduler. Use this information, together with an understanding of the science outputs and changing scientific landscape of the Rubin Observatory, to make recommendations for changes in survey strategy, including Target of Opportunity observations and the use of Director's Discretionary Time.

Next Steps

- Discussing topic with SAC (This Meeting!)
- Pre-COVID we aimed to have an initial plan for early science by end of 2020.
- Finalize plans later in FY21 (Rubin full operations proposal now planned for Dec 2021).
- Work with SAC to ensure we get the right input:
  - Reach out to all science collaborations, ensure they have had the chance to give input. Agree on a process for providing input.
  - Review community feedback on Alert Generation in year 1, understand what is possible and what the implications of the various scenarios are, and then present it to the SCOC for their recommendation.
  - Other

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Detail Slides

Alert Production in year one
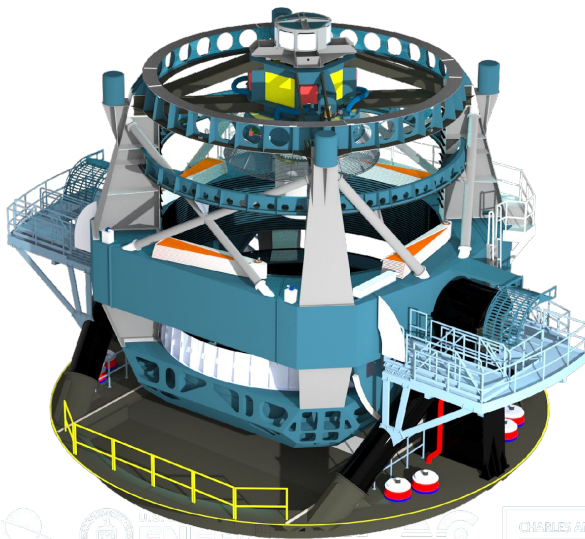
- Alerts are a product of Difference Image Analysis (DIA), which requires coadded transient-free template images.

- Templates are built during Data Release Production (DRP) and made available through LSST Data Releases.

- The LSST Data Release Scenario currently envisages Data Release 1 (DR1) for one year after the start of LSST operations, and to be based on the first six months of data.

- Consequently, Alert Production cannot run at full scale nor full fidelity in year 1.

- "Baseline" science thus implies from year 2.

Wide range of science-based observations and considerations from recent community input...

- High impact Solar System science prefers template generation options that maximize the sky coverage.

- Time critical TVS science enhanced by templates in multiple filters, preferably r and g bands

- To address the large range of variability timescales templates generated from images collected at a range of time separations is desirable

- DESC SN and SL WGs emphasize important of building good DDF templates in commissioning for SN science operations to begin in year 1,

- Noisier image subtraction compared to DR1 often preferred to no DIA at all

   …. etc and many more

Opportunities for High Impact Solar System Science During Year 1 of the Legacy Survey of Space and Time (LSST)

Megan E. Schwamb [1], Mario Jurić [2], Bryce T. Bolin [3,4], Luke Dones [5], Sarah Greenstreet [6,2], Henry H. Hsieh [7,8], Laura Inno [9], R. Lynne Jones [10,11], Michael S. P. Kelley [12], Matthew M. Knight [13,14], William T. Reach [15], Tom Seccull [16], Colin Snodgrass [17] And David E. Trilling [18]

for the LSST Solar System Science Collaboration

Impact of Rubin Observatory LSST Template Acquisition Strategies on Early Science from the Transients and Variable Stars Science Collaboration: Non-time-critical Science Cases

K. Hambleton[1] [iD], F. Bianco[2] [iD], G. Clementini[3] [iD], M. Dall'Ora[4] [iD], R. Egeland[5] [iD], N. Hernitschek[6,7] [iD], M. B. Lund[8] [iD], I. Musella[9] [iD], A. Prša[1] [iD], V. Ripepi[10] [iD], K. G. Stassun[6,7] [iD], R. A. Street[11] [iD], R. Szabó[12,13] [iD], and
On Behalf of the Rubin Observatory Transients and Variable Stars Scien...

Impact of Rubin Observatory LSST Template Acquisition Strategies on Early Science from the Transients and Variable Stars Science Collaboration: Time-critical Science Cases

R. A. Street[1] [iD], F. B. Bianco[2] [iD], R. Bonito[3] [iD], T. Giannini[4] [iD], M. L. Graham[5] [iD], R. Margutti[6] [iD], E. Mason[7] [iD], A. Pastorello[8] [iD], M. C. Stroh[6] [iD], P. Szkody[5] [iD] +Show full author list

Any opinions, statements (including statements about LSST and what it will deliver), or recommendations expressed on this forum are those of the author and do not necessarily reflect the views of the LSST Project.

Please take a moment to review our community guidelines.

Science-driven prioritization of sky templates during commissioning plans ✏️

■ Science   observingstrategy, commissioning

👉 This is the first time fedhere has posted — let's welcome them to our community!

fedhere Federica   1 ✏️ Nov '19

Let's generate a science-driven optimization of the template collection and generation plan for LSST during commissioning.

2 ❤️   🔗   🏳️   🔖   •••   ↩️ Reply

created	last reply	17	543	13	4	6	
Nov '19	Mar 29	replies	views	users	likes	links	

Nov 2019

1 / 18
Nov 2019

Mar 29

fedhere Federica   Nov '19

From the PST-SC chairs conversation on 11/20/2019, being clear that the templates for image differencing will only be available for a fraction of the sky (~10%?) by the end of commissioning, we should discuss what combination of sky areas and bandpasses should be prioritized and make recommendations for alert-generation in DR1. Different science drivers would lead to a different plan for template collection, e.g. trivially MW science would prefer templates in the galactic plane, EG science and cosmology outside of the plane. Please share this board with all of the SCs. At the appropriate time we will move this discussion to a more formal venue to make official recommendations.