Welcome!

Commissioning and Science Validation

~~Tuesday, 12 August 2020 @ 12:00-13:00 PDT~~

Chairs: Keith Bechtol and Chuck Claver

Rubin Observatory

For SSSC Commissioning Note brainstorming session 21 Oct 2020

Session Webpage:
link

Rubin2020_PCW Slack Channel:
#day2-tue-slot3a-commissioning

NSF AURA U.S. DEPARTMENT OF ENERGY SLAC CHARLES AND LISA SIMONYI FUND LSST CORPORATION

Call for Input from Science Collaborations

Rubin Observatory

See the LSST Community Post for more information. In brief:

- Project Commissioning team welcomes input from science community - your expertise is valued and appreciated!
- Two Phases:
  - **Phase 1:** Open call for Commissioning Notes
    - Formax flexible. Even a few pages are valuable; more information is welcome. Some indication of priorities is most useful.
    - Review begins Dec 2020. Notes can be updated as needed.
    - Project commissioning team will compile feedback, e.g., menu of candidate fields, list of reference external datasets, potential metrics for science validation.
  - **Phase 2:** Based on feedback, iterate with science collaborations to refine plans as we get closer to first light; exact timeline TBD.

Definitions

Rubin Observatory

Verification: did we build the thing we said we were going to build? (i.e., formal verification of OSS, LSR, and SRD requirements)

Validation: does the thing we built do what we want / expect it to do? (i.e., science user perspective)

Characterization: do we understand how / why the thing we built works the way that it does? (i.e., how can we optimize operational performance of the as-built Rubin observatory)

Emphasis

Rubin Observatory

The Project needs to take on-sky observations that will allow us to do the science verification analyses to formally demonstrate construction completeness.

Where flexibility exists, our goal is to take these observations in such a way that also enables science validation (e.g., through careful selection of target fields, cadence, depth, area, and band coverage, overlap with external reference datasets).

The science validation component is where we particularly appreciate help from the community who understand the detailed data quality needs for their science.

Emphasis

Rubin Observatory

We are trying to optimize data-taking during the commissioning period to

- maximize our understanding the as-built system capabilities,
- make informed decisions about observatory operations / survey strategy, and
- prioritize ongoing developments/refinements of the science pipelines and data access services.

We are not necessarily trying to optimize science output from the commissioning data itself.

Emphasis

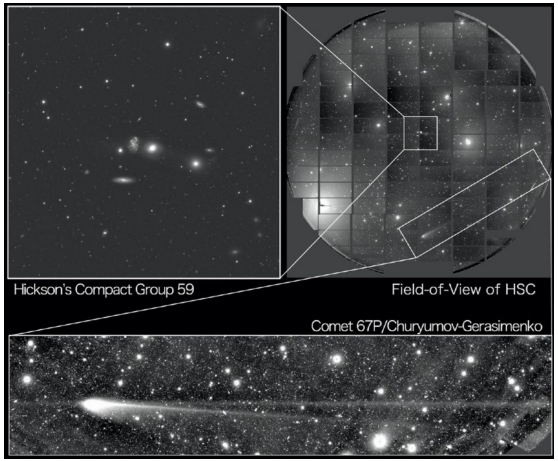
Rubin Observatory

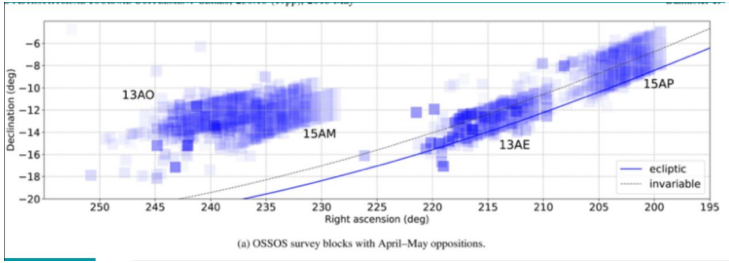
- Are we routinely acquiring raw pixel-level data of sufficient quality to be used for template generation to support difference image analysis in the early years of the survey?
- Are we routinely acquiring raw pixel-level data of sufficient quality to be used for data release processing, both in the early data releases, and subsequent years?
- If there are data quality anomalies, can they be corrected in software? Do they need to be addressed in hardware / observing strategy / observatory operations?
- To what extent would the nominal planned observing strategy for LSST support various science cases, considering both for the deep drilling fields and wide-fast-deep survey? How many images are needed for effective template generation? What dither pattern should be used?
- Where do we need to focus effort on the science pipelines in the months leading up to the first data releases?
- Are we prepared to produce photometric redshifts from the early data releases? How will we scientifically validate the performance of photometric redshifts?
- Is our strategy for photometric and astrometric calibration sufficient?
- How can we optimize delivered image quality for various science cases? Is our modeling of the PSF sufficient to support various science cases?
- How can we scientifically validate and improve performance with respect to object detection, (de)blending, and background treatment? As a function of object density? As a function of image quality and sky brightness?
- Are there systematics associated with instrument coordinates, atmospheric conditions, etc.?
- Are the data access services meeting the needs of science users for realistic scientific workflows?

SSSC Input from PCW 2020 Parallel Session

Rubin Observatory

- Imaging Previous Deep Survey Regions (e.g., OSSOS)
- Observing a comet
- Imaging a giant planet as a saturated source
- Searching for additional Lucy encounter targets





(a) OSSOS survey blocks with April–May oppositions.

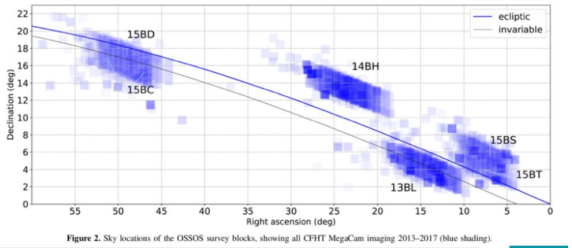


Figure 2. Sky locations of the OSSOS survey blocks, showing all CFHT MegaCam imaging 2013–2017 (blue shading).

Potentially Relevant System-level Requirements

Rubin Observatory

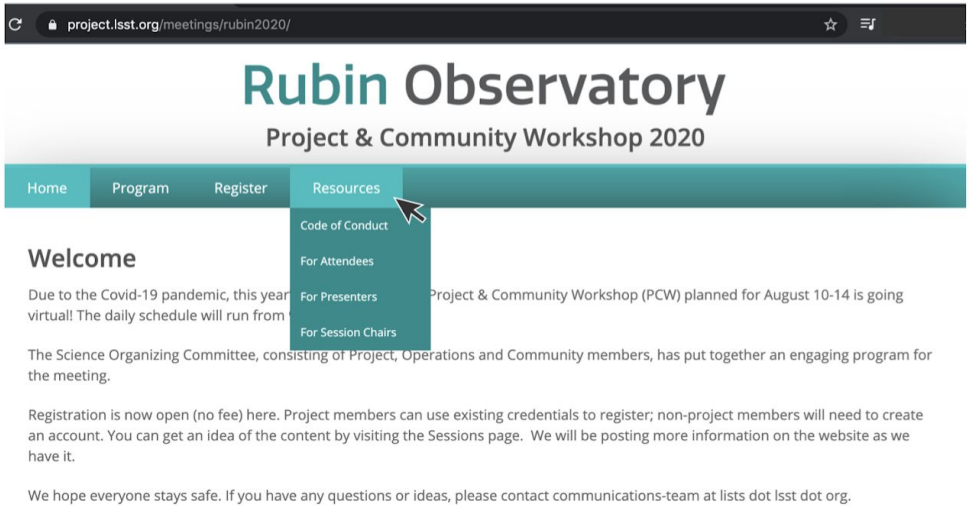
- Astrometry: repeatability, relative, cross-band (color), and absolute
- Photometry: repeatability, relative, cross-band, and absolute
- System throughput (individual visit)
- Stray and scattered light
- SSO Orbit availability
- *"Valid identification and orbits shall be determined for at least a fraction orbitCompleteness of Solar System objects which are detected orbitObservations times in orbitObservationInterval days at a level orbitObservationThreshold sigma or more above the single frame background."*
- *"The Observatory shall develop a metric to characterize the probability of each reported difference source being spurious."*
    - *"The performance of this metric will be assessed by simulations, by insertion and recovery of artificial sources, and comparisons to ground truth where known (i.e., asteroids, known variable stars, known variable quasars, etc.)."*
- *"There shall exist a spuriousness threshold T for which the completeness and purity of difference sources are higher than mopsCompletenessMin and mopsPurityMin, respectively, at the SNR detection threshold orbitObservationThreshold. This requirement is intended to be interpreted as an average for any one month of observing."*
- *"The LSST Observatory shall produce the necessary data products to support the Taking an Inventory of the Solar Systemscience case described in the LSST SRD"*

See OSS (LSE-30) and LSR (LSE-29) for details

Friendly Reminders

Rubin Observatory

You agreed to abide by the Code of Conduct at registration - it can be found here on the website



Rubin adheres to the principles of Kindness, Trust, Respect, Diversity and Inclusion in order to provide a learning environment that produces rigor and excellence.

Any discriminatory behavior against colleagues on any basis, such as gender, gender identity, race, ethnic background, national origin, religion, political affiliation, age, marital status, sexual orientation, disabilities or any other reason will not be tolerated.

If I witness any form of bullying, harassment or aggression I will follow the reporting instructions in the Code of Conduct.

Reminders

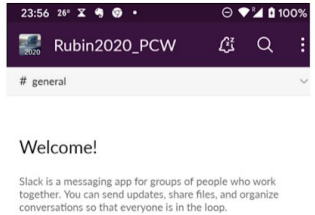
Rubin Observatory

All talks at this workshop will be recorded.

If you do not wish to be recorded, you are welcome to keep your camera off.

Videos are posted the next working day.

Each session will be posted on YouTube and embedded on the session's page.



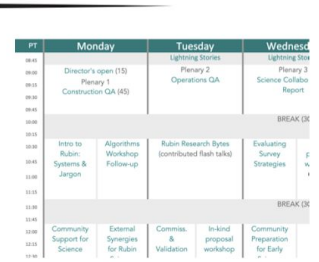
Ask questions through the Slack channel or the Zoom chat.

Give Slack questions a thumbs-up.

Questions with more thumbs up may get priority if time runs short.

Show your appreciation.

Feel free to applaud at any time but especially at the end - Slack has a clap emoji.



You can access the presentation material on the session page.

Session Logistics

Rubin Observatory

Please post questions / comments on Slack channel rather than Zoom

Moderators: Keith Bechtol and Chuck Claver

Monitoring Slack for questions: Markus Rabus

Scribes: Jeff Carlin and Kevin Reil

Minutes: google doc (editable by anyone with link)

Goals for Today

Rubin Observatory

- This parallel session is meant to be a starting point for discussion as the Project continues planning and preparations for on-sky commissioning activities
- We have invited the Science Collaborations to share snapshots of their current thinking and questions in brief presentations today
- By end of session, we hope that the Science Collaborations will have more information and resources for drafting “commissioning notes” that can be posted in the public domain and that the Project can consider when planning of on-sky observations during commissioning
    - Further discussion and iteration will likely be beneficial as we get closer to first light

We are here to listen to you!

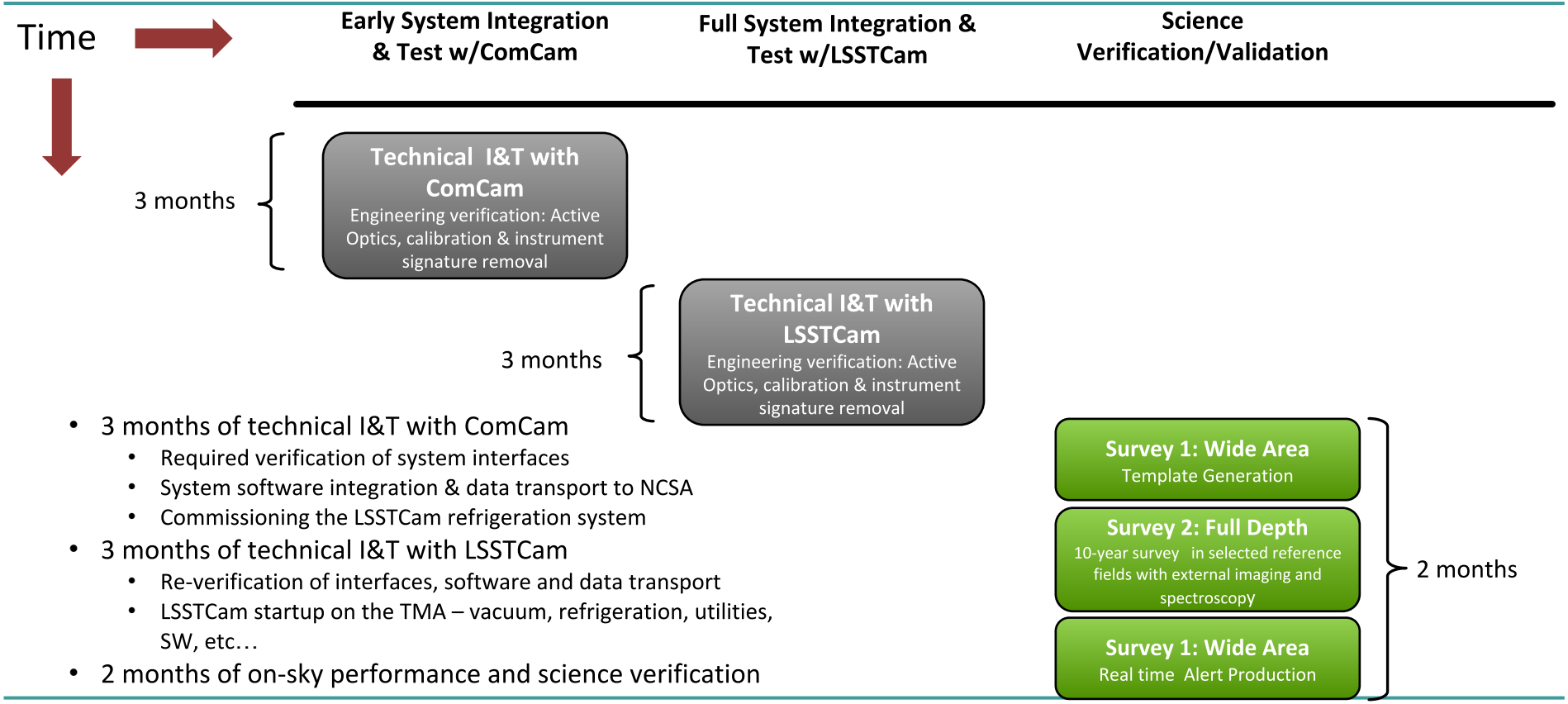
Agenda

Rubin Observatory

- **Introduction** - Keith Bechtol and Chuck Claver (10 min)
  - Education and Public Outreach Considerations - Lauren Corlies
- **Science-driven considerations for on-sky observing**
  - Dark Energy Science Collaboration - Chris Walter (15 min)
  - Solar System Science Collaboration - Matthew Tiscareno, Meg Schwamb, Hal Levison, Marc Buie, Michael Kelley (15 min)
  - Galaxies Science Collaboration - Lee Kelvin (5 min)
  - Transients and Variable Stars Science Collaboration - Markus Rabus (5 min)
  - TVS / SMWLV - Massimo Dall'Ora (5 min)
  - Stars, Milky Way, & Local Volume Science Collaboration - Will Clarkson (5 min)

Current On-sky Observing Schedule

Rubin Observatory



- 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

Current Commissioning Data Expectations

Rubin Observatory

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

Managing Expectations for Community Input

Rubin Observatory

Data content from commissioning is a “shared risk” / “best effort” situation:

- Project needs to prioritize technical and scientific verification of formal system requirements to demonstrate construction completeness in a timely fashion
- The detailed schedule for on-sky commissioning observations is TBD
- The Commissioning Team has already been planning to acquire on-sky observations that would enable science validation studies for the four main science drivers of the LSST
  - **Guidance from science community is welcome and appreciated to enhance opportunities for science validation studies based on commissioning data**
- Commissioning observations are NOT an observing proposal / TAC process
  - We cannot ensure that any particular observations will be taken during commissioning

Proposed Process to Provide Input

Rubin Observatory

To provide guidance for the on-sky observing strategy during commissioning, the Science Collaborations are encouraged to produce summary documents, “commissioning notes”, that are placed into the public domain and can be considered by the Commissioning Team.

Suggestions:

- Commissioning liaisons curate guidance from their respective collaborations
- Structure of “commissioning notes” is flexible (~2 pages will be valuable)
- Supplemental digital resources welcome
- Input posted by ~~Nov~~ Dec 2020 would be considered as input to Project re-plan
  - Periodic updates after that are welcome
- Based on input received, Project and Community will iterate to refine proposals

What can be done in 1 night?

Rubin Observatory

For purpose of estimation, take a typical night to be ~8 hours. Consider an average time between visits of ~40 seconds. This corresponds to ~720 visits per night, and realistically somewhat less due to filter changes, slews, variable conditions, etc. Allowing 85% efficiency, ~600 visits per night

For comparison, the 10-year depth from SRD is

Specification: The sum of the median number of visits in each band, Nv1, across the sky area specified in Table 22, will not be smaller than Nv1 (Table 23).

Quantity	Design Spec	Minimum Spec	Stretch Goal
Nv1	825	750	1000

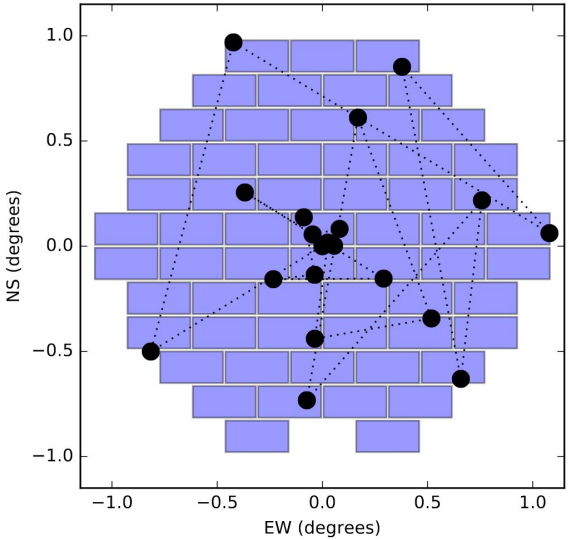
Quantity	u	g	r	i	z	y
Nv1 (design spec.)	56 (2.2)	80 (2.4)	184 (2.8)	184 (2.8)	160 (2.8)	160 (2.8)
Idealized Depth	26.1	27.4	27.5	26.8	26.1	24.9

What can be done in 1 night?

Rubin Observatory

A few representative possibilities:

- An LSSTCam star flat with with 20 visits in each of 5 bands would take ~80 minutes
  - Area includes ~10^5 Gaia reference stars
- ~325 deg^2 to ~1-year WFD equivalent depth (18 visits) in a single filter
- 10-year WFD equivalent depth in 4 bands for a single pointing, spanning range of airmass



Example DECam star dither pattern
Bernstein et al. 2017
arXiv:1703.01679

Field Name	Optimal Date	Optimal Airmass	$T_{1.4}$ (hr)	$T_{2.0}$ (hr)	Dates $\sec(z) < 1.4$	Dates $\sec(z) < 2.0$
LSST DDF ELIAS S1	Oct-01	1.03	7.1	9.6	May-15 to Jan-21	Apr-25 to Feb-18
LSST DDF XMM-LSS	Oct-28	1.11	5.1	7.5	Jun-23 to Feb-04	Jun-05 to Mar-03
LSST DDF Chandra Deep Field South	Nov-14	1.00	6.7	8.1	Jun-26 to Mar-17	Jun-09 to Apr-13
LSST DDF COSMOS	Feb-21	1.18	4.2	6.9	Nov-24 to Jun-21	Oct-28 to Jul-10

Table from DESC Note

Education and Public Outreach Considerations

Rubin Observatory

EPO's main early goals involve generating excitement about the observatory and beginning to populate our products with LSST data.

No strong preference for specific objects but characteristics that would best serve our needs include:

- Color images of photogenic galaxies or nebulae to spark public interest
- Reasonably large, continuous patch of sky covered in all six filters to test EPO image coloring algorithm and creation of HiPS files for all-sky viewer
- Alert stream production from ideally the same patch of sky to populate website and adding transient objects to our products